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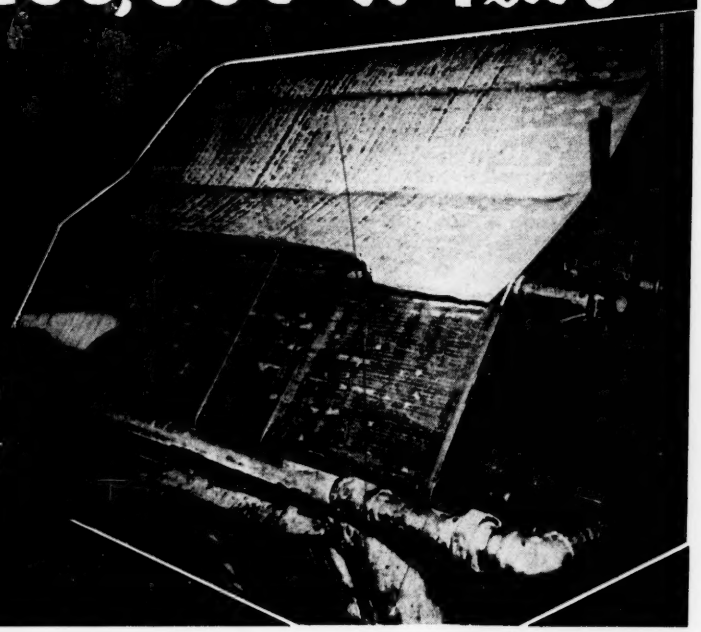
Chemical Engineering

A McGRAW-HILL PUBLICATION

Predict Drafting Costs

page 114

Saves $200,000 a Year



EIMCOBELT
CONTINUOUS BELT
DRUM FILTER

A chemical processor was recovering gypsum by thickening followed by two stages of countercurrent washing on standard drum vacuum filters.

The filtration was not satisfactory. Excessive blinding of cloth filter media resulted in a daily loss of hundreds of pounds of valuable product.

When an EimcoBelt filter replaced the standard drum filter for the first filtration stage in this operation, it immediately overcame all blinding difficulties. Soluble losses were reduced to less than one-third of the average former loss experienced with the two conventional drum filters . . . resulting in savings of over $200,000 a year.

It soon became apparent that the EimcoBelt could handle the filtration load formerly handled by the two drum filters. Accordingly, the second stage drum was eliminated from the flow-sheet.

Freedom from blinding is one of several ways the new EimcoBelt filter is greatly extending the usefulness of vacuum filters.

EimcoBelt filter's unique new operating principle removes the filter medium from the drum every cycle, discharges the cake and washes the medium while it is away from the drum. A thoroughly cleaned medium is always returned to the drum.

Ask the Eimco representative in your area how EimcoBelt filters can cut costs in your operations. And write Eimco Filter Division for Bulletin F - 2053.

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634 SOUTH 4TH WEST
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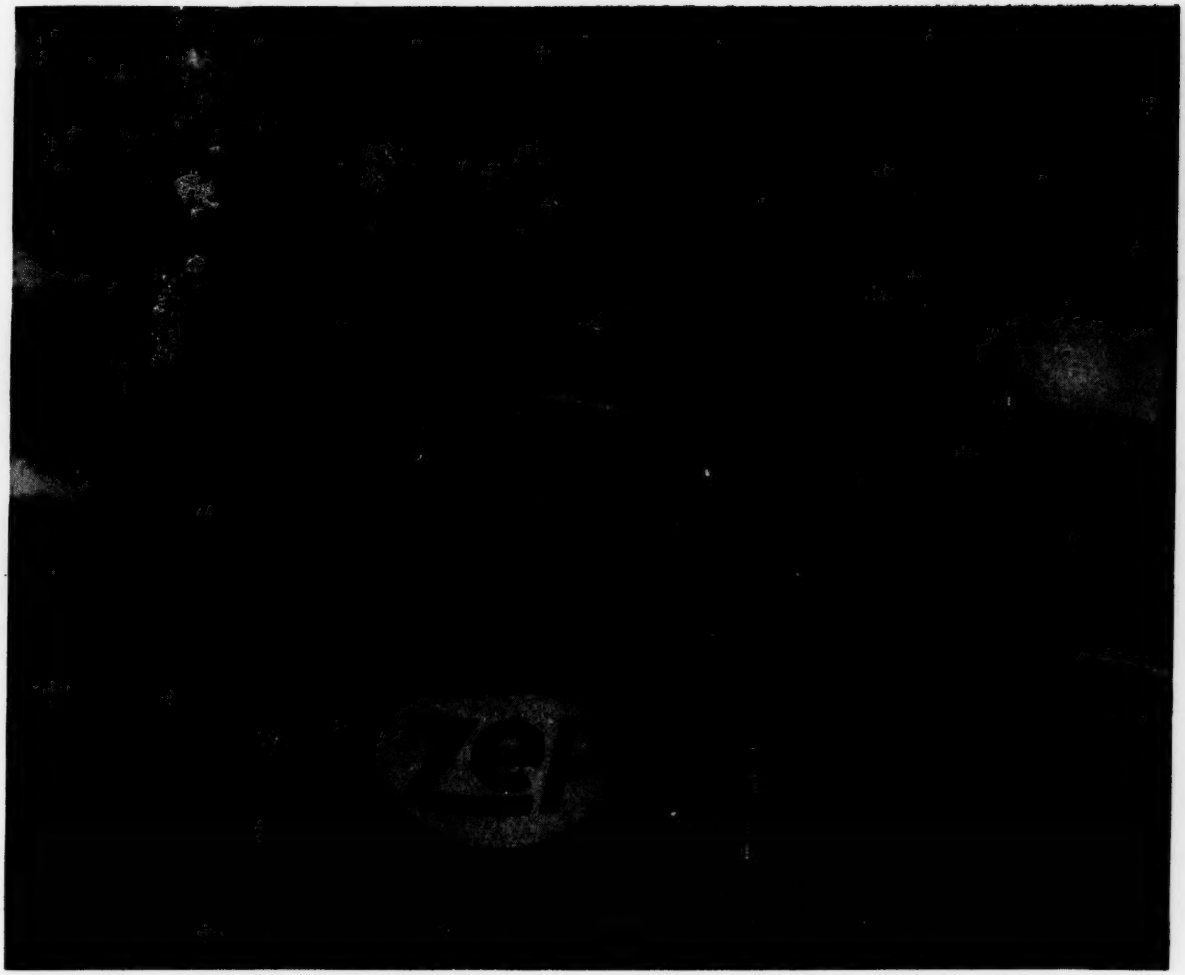


Koroseal keeps contamination out of cleaning compounds

Koroseal PVC pipe, by B.F.Goodrich, ends corrosion too

EVEN stainless steel can't handle some of the chemicals used in this plant. Corrodes too fast! But the real problem is that metal pipe would contaminate some of the commercial cleaning compounds produced here. That's why Koroseal PVC pipe was installed on all lines where corrosion or contamination could cause trouble.

Koroseal won't corrode. It's unaffected by most acids, alkalies, salt, alcohol and oil. Solutions carried remain pure. Koroseal pipe does not react chemically, will not contaminate products.

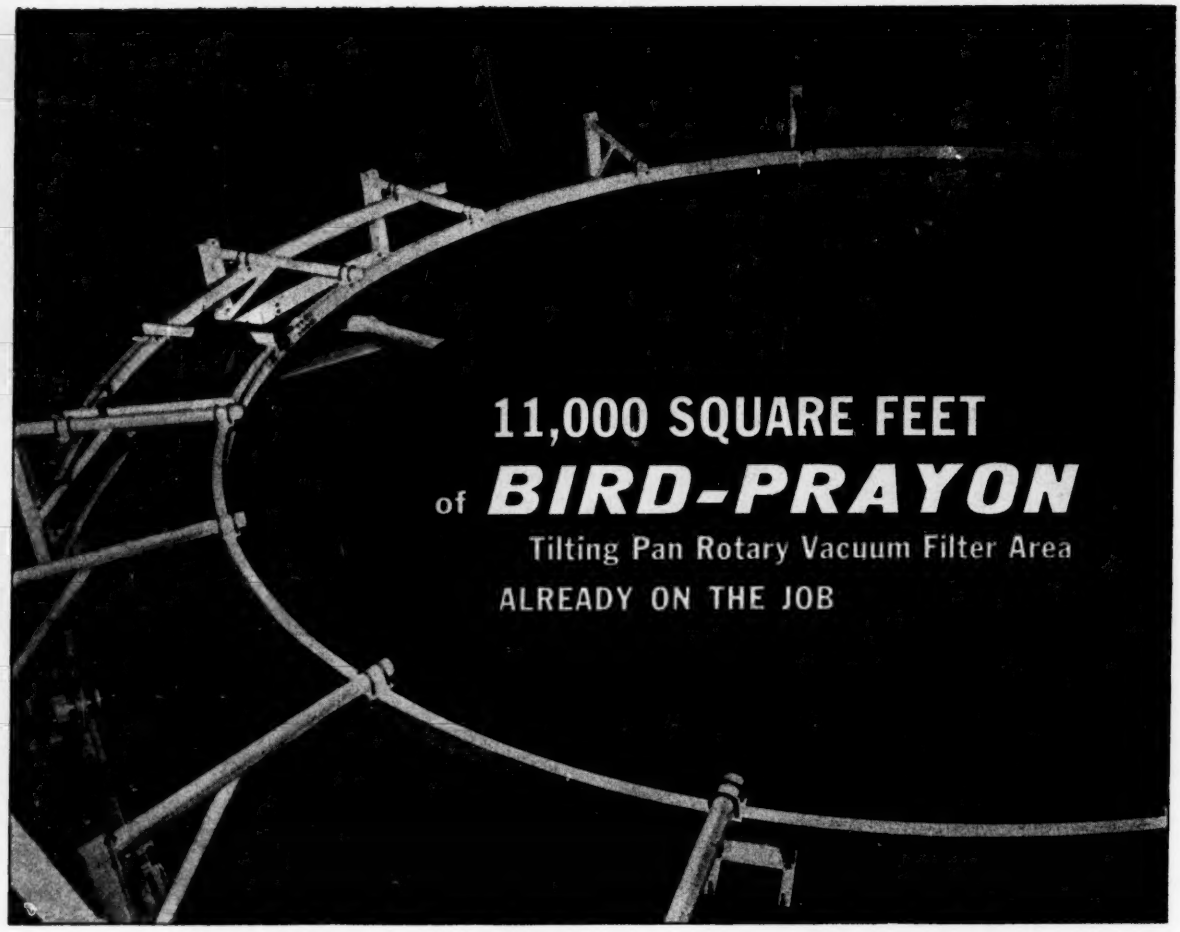
Koroseal was first tried out by the Zep Manufacturing Corp., Atlanta, Ga., about 10 years ago. Since then, they've found many more uses for it, and have never had to make a replacement because of chemical corrosion. Installation is simple. Koroseal pipe can be threaded, welded, cemented. And according to Zep's engineers, "component fittings, valves and pipe fit together like the parts of a fine watch."

More and more manufacturers are finding Koroseal PVC pipe ideal for use wherever chemical resistance, high working pressures, good impact resistance are factors. Longer service life and low installation costs make rigid Koroseal competitive with conventional piping material.

For the full story on Koroseal's many advantages, get in touch with a B.F.Goodrich distributor or write for a free booklet. *B.F.Goodrich Industrial Products Co., Department M-842, Akron 18, Ohio.*

Koroseal—T.M. Reg. U.S. Pat. Off.

B.F.Goodrich **Koroseal rigid PVC products**



Why? Because the industry recognizes and appreciates the ease of operations, washing efficiency and economy of the Bird-Prayon, and the fifteen years of engineering and application experience that won it the lion's share of all installations of its type, the world over.

This eleven thousand foot endorsement of the Bird-Prayon has been amply substantiated by its performance record — *long sustained operating cycles, super-efficient wash with sharp separation of liquors, freedom from cloth blinding, constant high output, and the very minimum of maintenance attention and expense.*

May we mail you an illustrated descriptive Bulletin on the Bird-Prayon Filter?

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MACHINE COMPANY

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May 30, 1960 **Chemical Engineering** Vol. 67 No. 11

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

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* FREE—for your files—Check Reader Service postcard (p. 149) for an extra copy of this article on containment materials for low-temperature processing.

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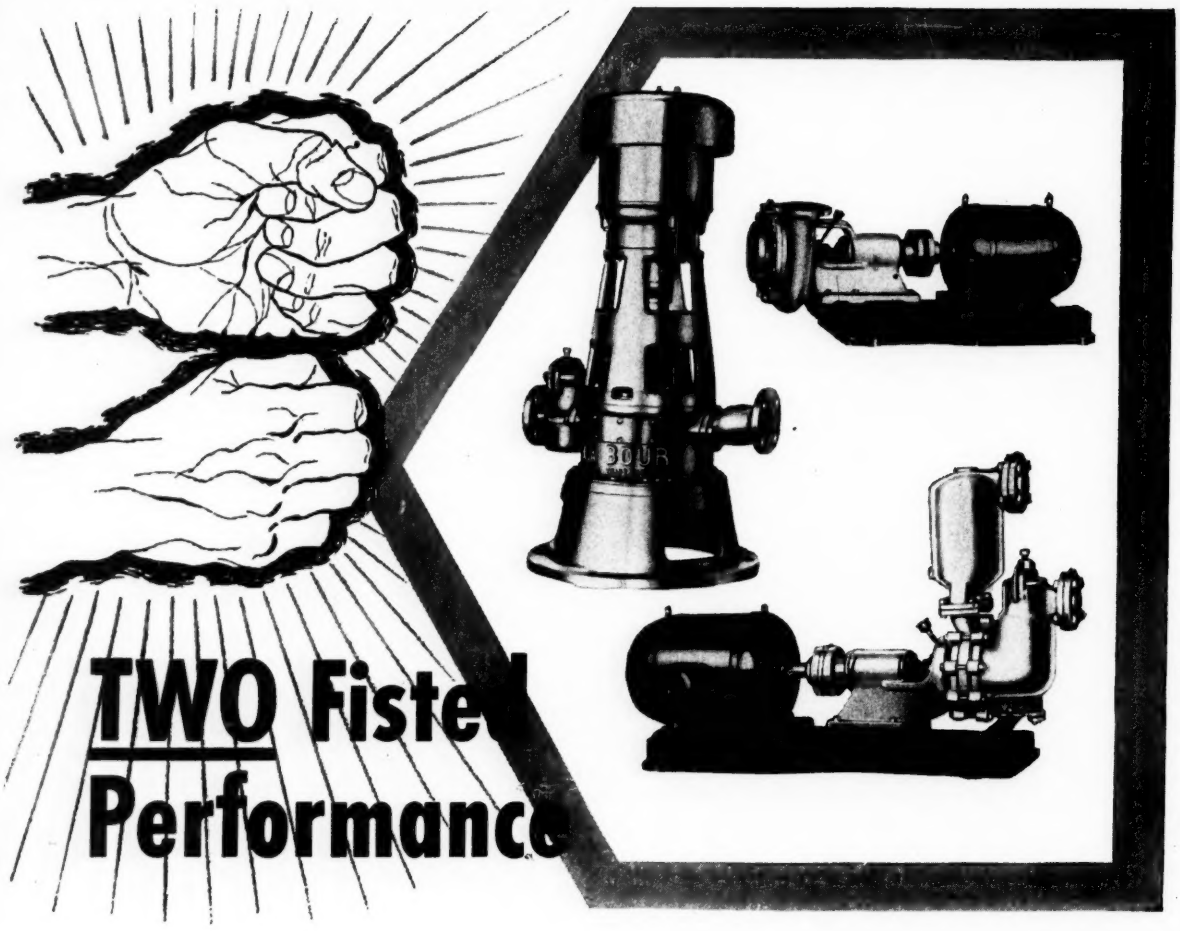

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Because LaBour pumps embody such important and exclusive features of design it is perhaps easy to overlook the fact that LaBour foundries employ equipment and techniques second to none for precise control of alloy composition and grain structure.

That's why, when you buy LaBour, you get *two*-fisted performance assurance. Top ability to resist corrosion *and* top ability to move liquids economically and dependably are combined in these pumps. Ask for Bulletin B-1b.

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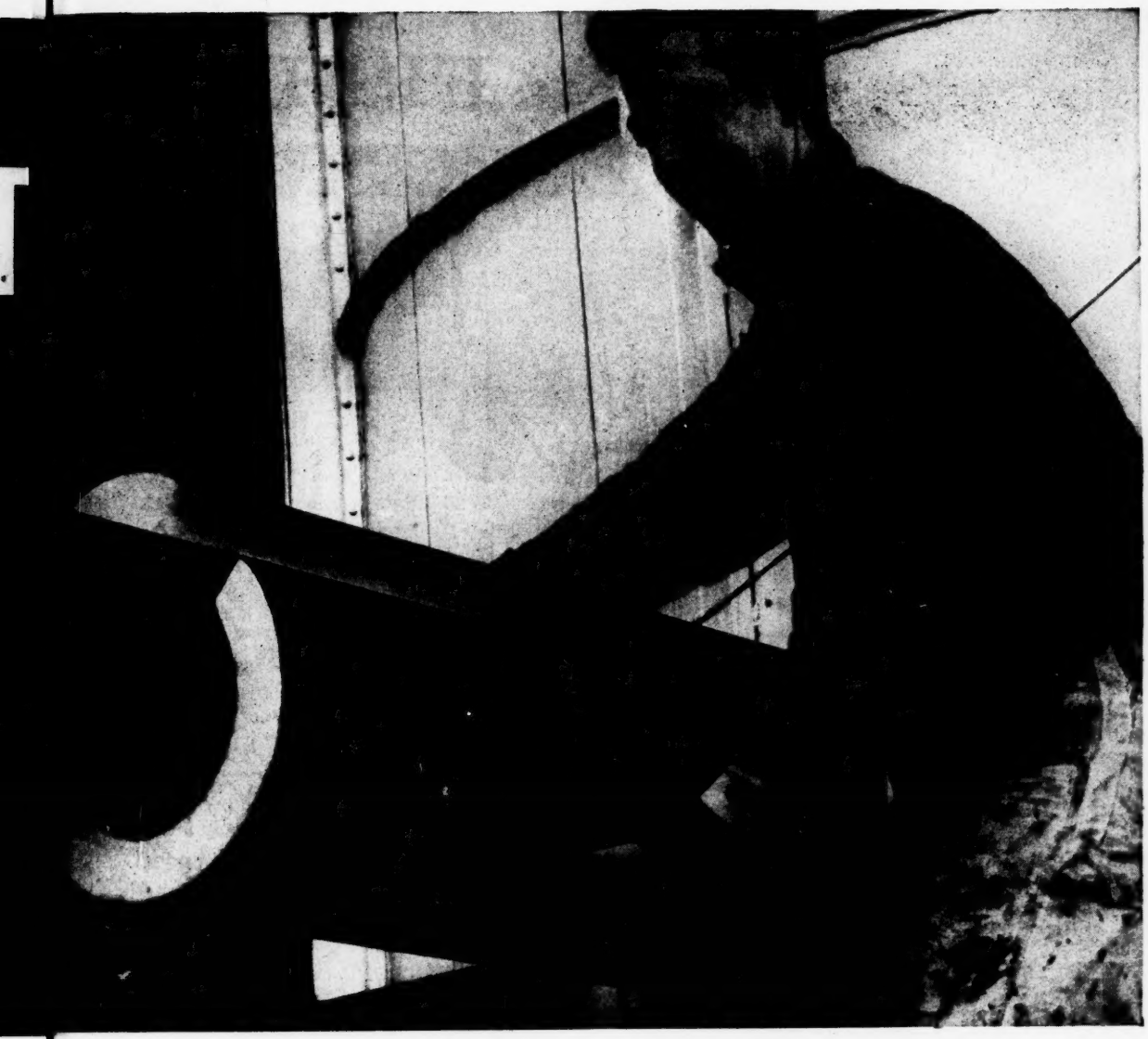

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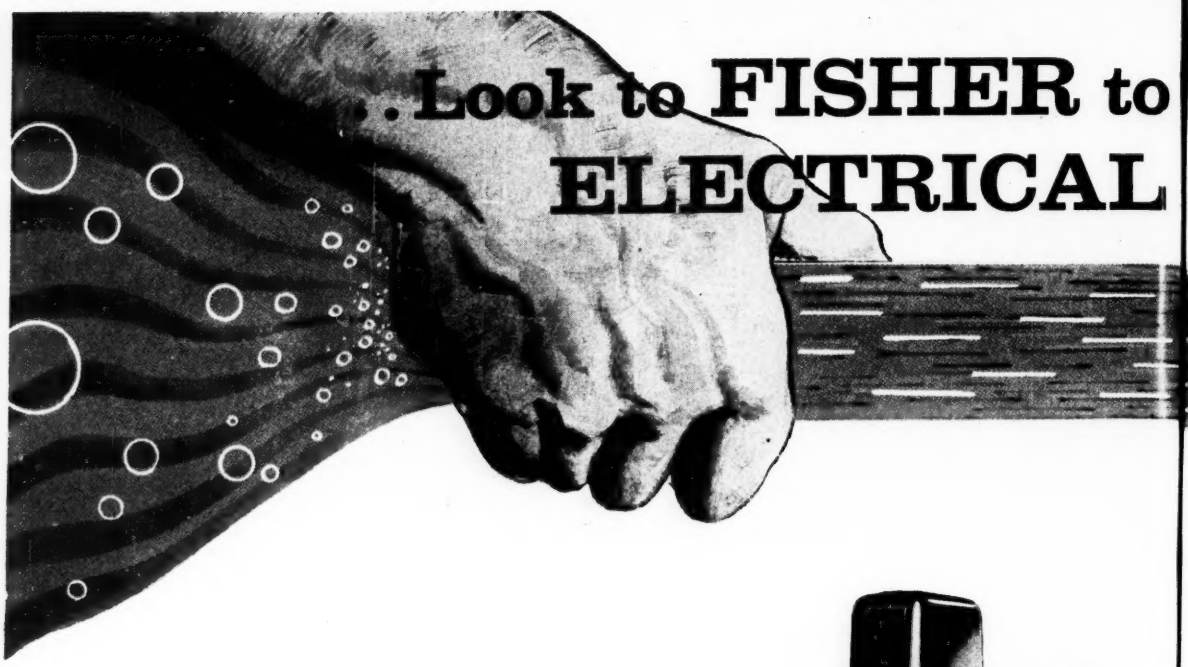

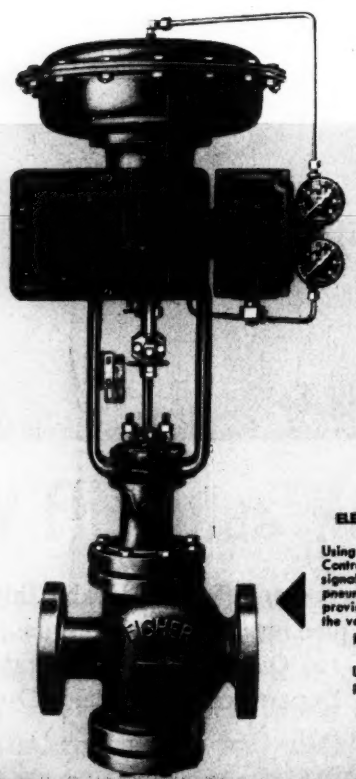

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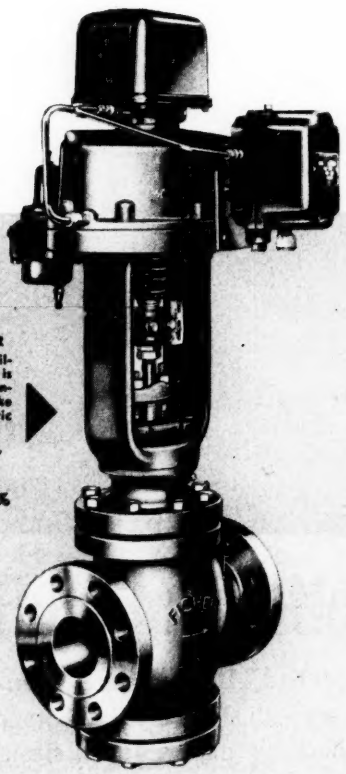
Linearity—1% of Full Range

Resolution Sensitivity—Less than 0.1% of Input Range.



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Using a conventional Fisher diaphragm Control Valve, the E-Positrol receives a Ma signal and translates this to a proportional pneumatic signal to a positioner which provides the speed and power to operate the valve.

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IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD CHANCES ARE IT'S CONTROLLED BY

to supply the muscles for your L CONTROL SYSTEMS

The old adage, "a chain is as strong as its weakest link" can be equally applied to the "muscle" or more correctly the final control element on any control loop. The importance of a control valve in an electronic system should never be considered lightly and that is why you should look to Fisher for assurance in furnishing dependable and accurate control valves for your electrical or electronic system.

Described below are three types of actuators that offer an exceptionally practical and economical approach for control valves in electrical control loops.

TYPE 543
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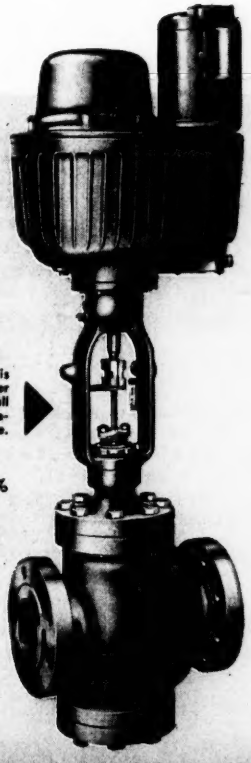
Incorporating its own relay booster, the 543 transducer can be installed either on or away from any type of pneumatically operated diaphragm control valve. Available in same input current ranges as other transducer models.



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In electrical control systems where air is not available or desirable, the Fisher Electro-Hydraulic Actuator provides all the necessary requirements for a dependable and accurate control valve.
Maximum Stem Thrust..2000 pounds
Stroking Speed.....0.37 in./sec.
Resolution Sensitivity...less than 0.05%

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DESIGN KNOW-HOW PUTS PRODUCTION PLUS IN SHIP LOADING SYSTEM

Barber-Greene solves challenging gypsum handling problem at lowest initial and operating cost

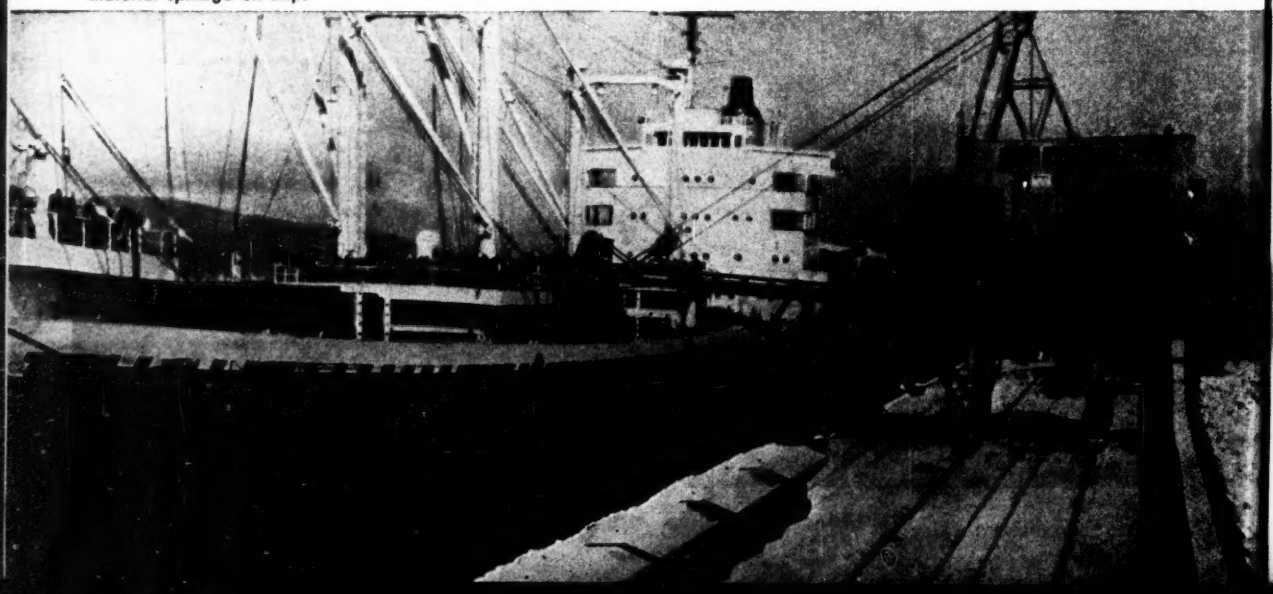
PROBLEM: Design system to unload railroad cars, stockpile 100,000 tons of material in limited area and load ships at Latin American mine and processing plant.

SOLUTION: Barber-Greene engineers developed several designs and recommended the system that met the customer's production requirements and held initial investment to a minimum. And by drawing on 40 years of conveyor experience, Barber-Greene engineers were able to utilize heavy-duty standardized components for over 70% of the job. Operators found the system so dependable and easy to operate that estimated loading time of ships was reduced 25%. Owner benefited two ways: increased production and reduction of shipping costs due to shorter ship loading time charges.

Barber-Greene engineers first made an over-all operational analysis of material handling at both terminal and mine, seven miles away. Such an analysis, an important part of Barber-Greene's service, allowed both customer and engineers to establish present and future requirements and better judge the relative merits of the recommended system.

This customer's satisfaction with his installation

Barber-Greene engineers saved owner $50,000 by revamping old whirly crane as base for 42" conveyor shown loading gypsum reclaimed from stockpiles. Extra wide belt eliminates material spillage on ship.



is best indicated by the fact that he recently placed an order for additional Barber-Greene Conveyors to expand the terminal operation.

Call your Barber-Greene conveyor representative for a sound solution to your bulk material handling problems. He offers the most efficient system that can be provided by engineers equally adept at custom engineering and standardized design. In addition, he offers undivided responsibility for preliminary and final design, fabrication and erection.

Installation at ship loading terminal features a double winged stacker mounted on a traveling tripper which stockpiles in an area 312' long. Reclaim conveyors under piles direct material to traveling gantry at dock side which loads ships at 675 tph capacity.

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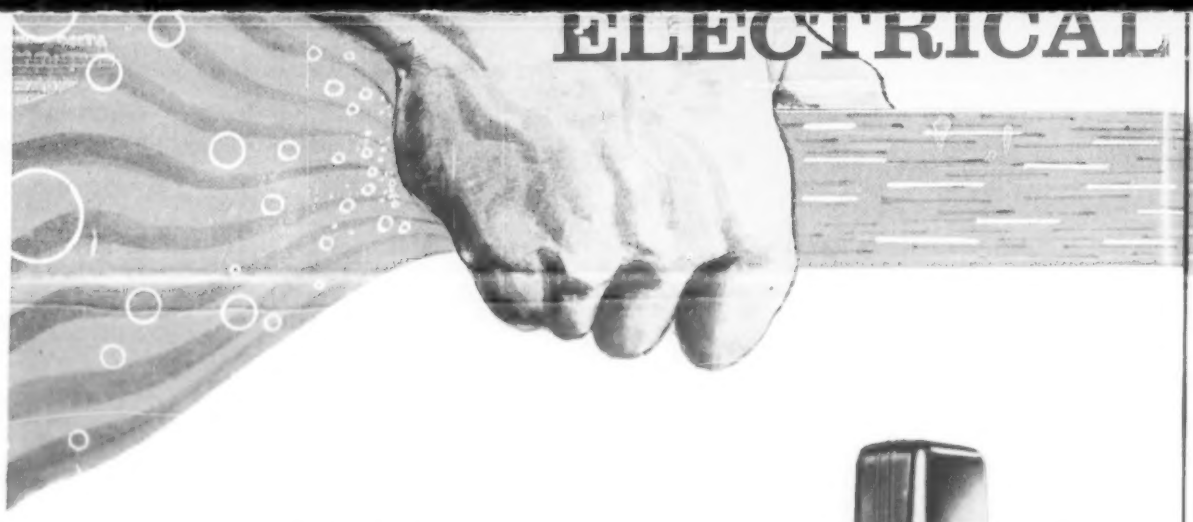
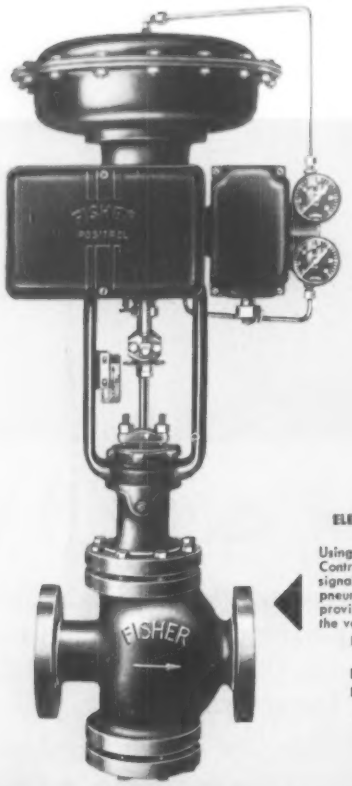
MONEY-SAVING DESIGN: Three 8' x 8' hoppers were used to receive gypsum brought to terminal from mine by side-dump rail cars. Single hopper would have been very expensive to construct since water was near ground surface at this point.

ELECTRICAL





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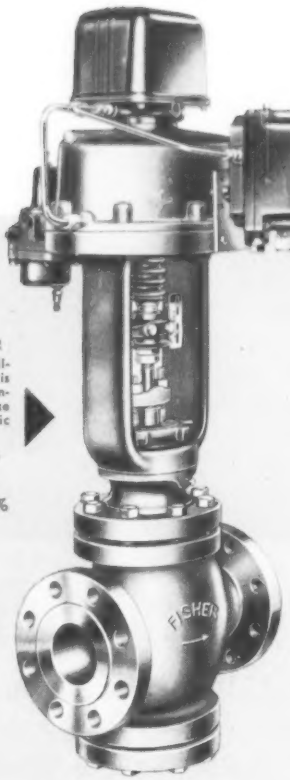

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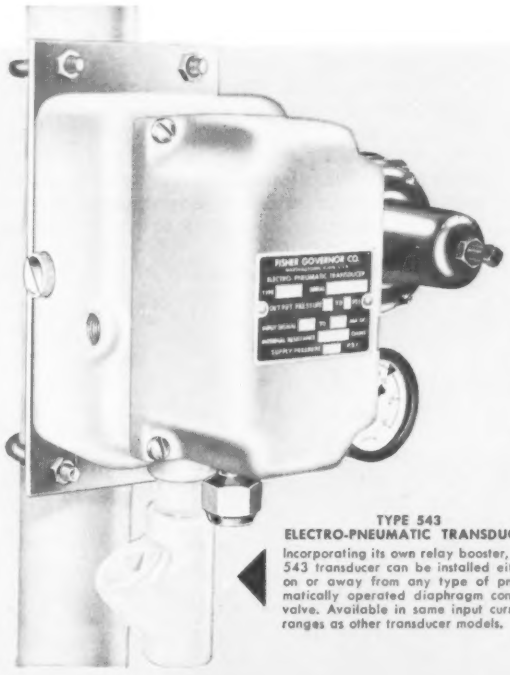

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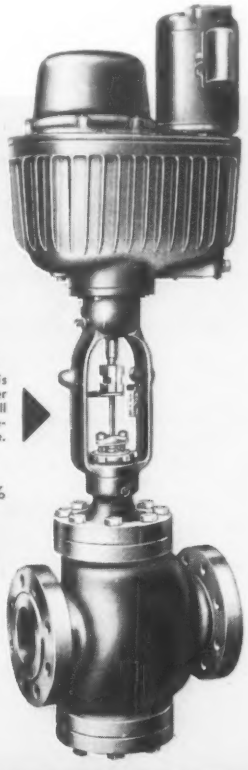

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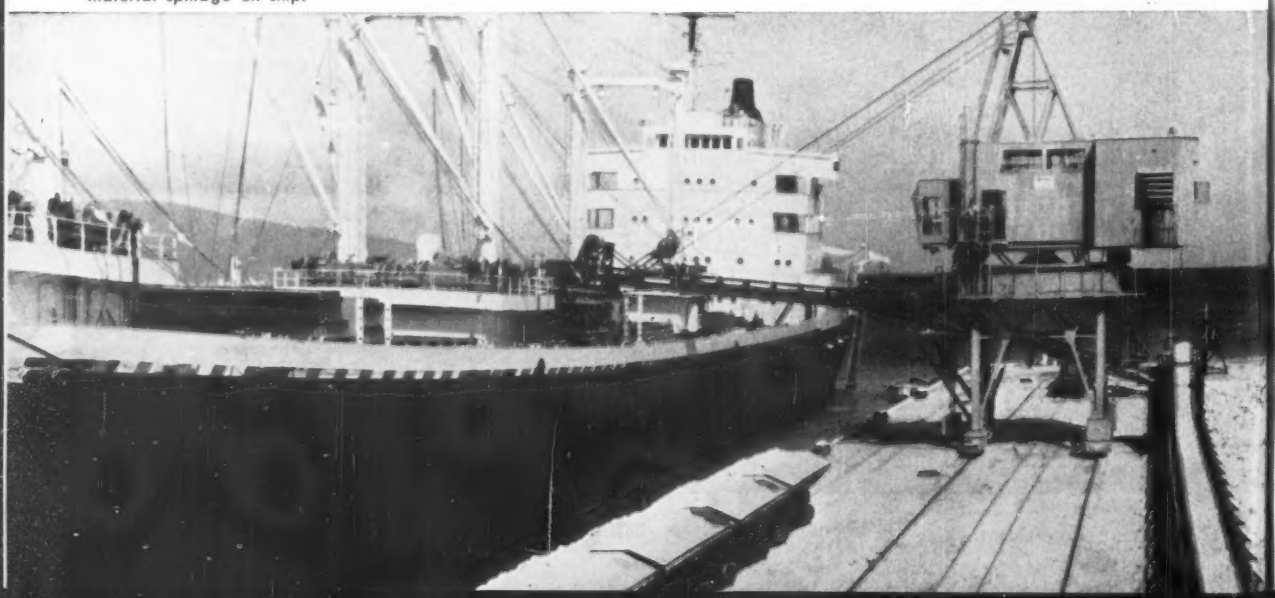

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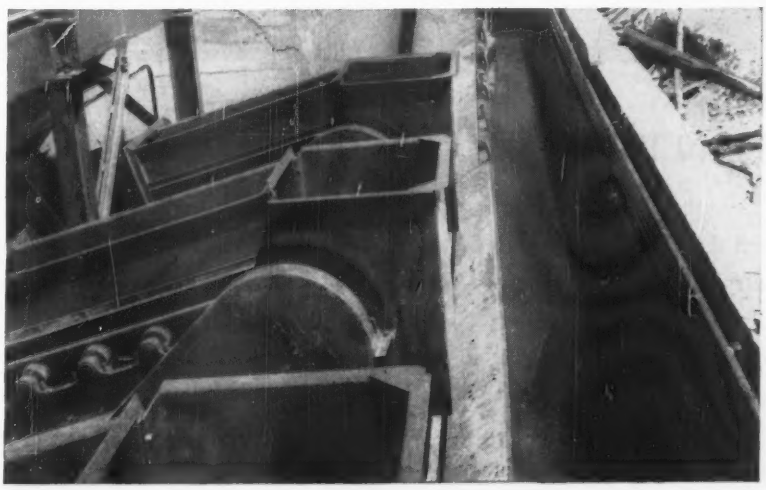

MONEY-SAVING DESIGN: Three 8′ x 8′ hoppers were used to receive gypsum brought to terminal from mine by side-dump rail cars. Single hopper would have been very expensive to construct since water was near ground surface at this point.

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From the photographer's stop bath to the production of fibers, the applications for acetic acid make it one of industry's most useful chemicals. Celanese has the largest acetic acid plant facilities in the world, with capacity nearly doubled recently to attain a new high of over 400 million pounds a year for the two basic acetyl chemicals—acetic acid and acetaldehyde. One of the most important organic acids, acetic is made at Celanese from petroleum gases by a unique oxidation process developed in Celanese laboratories at Clarkwood, Texas. The material is so pure that it exceeds U.S.P. specifications. It is used in the manufacture of cellulose acetate fiber and plastic, vinyl monomers, solvents, dyes, metal salts, pharmaceuticals and many other chemicals.

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CHEMICALS

Canadian Affiliate: Canadian Chemical Company Limited, Montreal, Toronto, Vancouver
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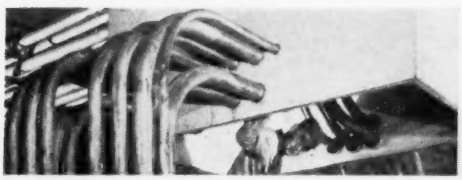
Where PRODUCT PURITY is important, protection gets a hand from Alcoa

When protection against contamination from *any* source is vital, take a look at what Alcoa aluminum electrical rigid conduit offers. ¶ It needs *no* protective coating, because it forms its own—an oxide film that repairs itself when damaged. ¶ It's corrosion-resistant—stands up particularly well against acids commonly present in food plants: citric, acetic, tannic. And the compounds that might form when aluminum is used are in most cases *nontoxic*, completely safe. ¶ What else? Aluminum is lightweight (weighs about 1/3 as much as steel), so it's easier to install. Alcoa conduit is also nonmagnetic, nonsparking, and neat appearing. ¶ Consider all costs—initial, installation, maintenance—plus long service and you'll see why Alcoa aluminum conduit is a sound investment. ¶ For full details, contact one of our nearby representatives. Or write to Rome Cable Division of Alcoa, Dept. 22-50, Rome, New York.



◀ ADDED PROTECTION against product contamination is provided by Alcoa aluminum conduit. It needs no protective coating, resists corrosion, and is nontoxic.

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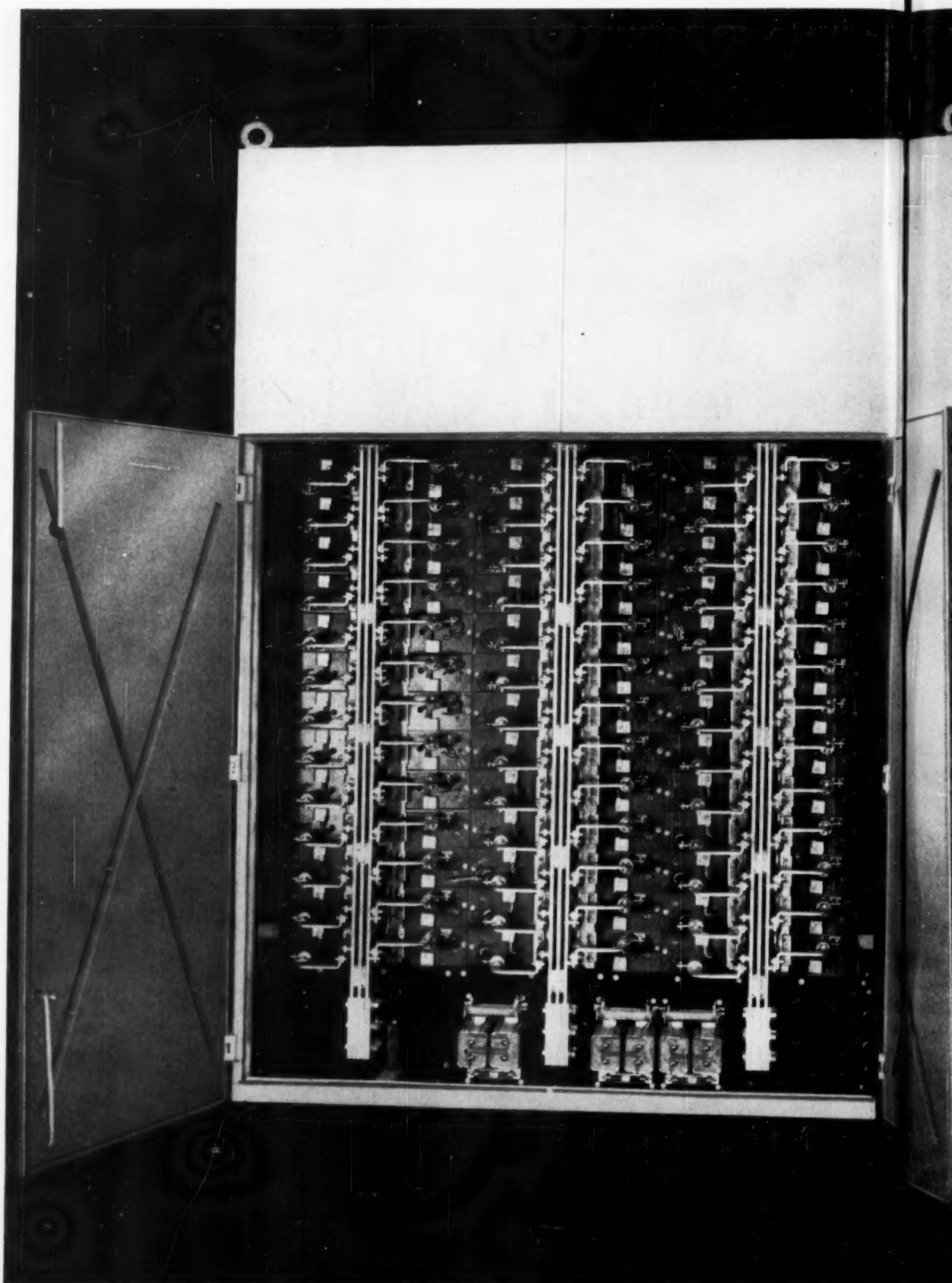
DIVISION OF **ALCOA**



Now available for all electrochemical processing voltages...

New Westinghouse Silicon Rectifiers Give You Higher Efficiency in Less Space at Lower Cost

Helping you curb the high cost of processing is the job of these new high-efficiency Westinghouse silicon rectifiers. Cost of power—as reflected in final product costs—is now made lower than ever before.

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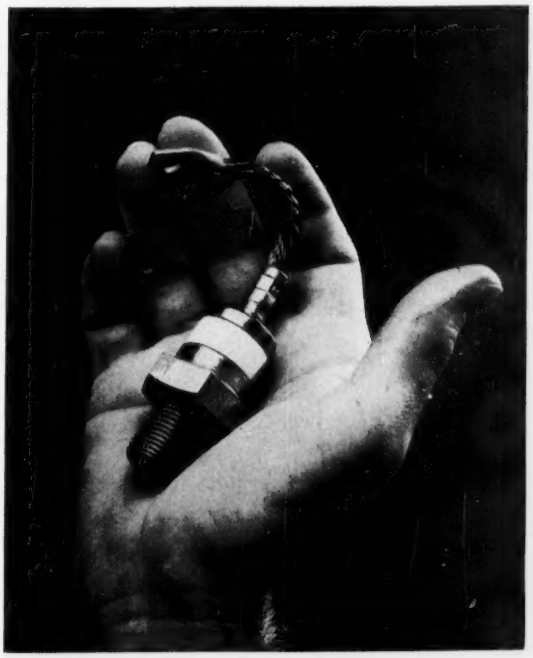
- **Low first cost** . . . advanced circuitry eliminates complicated excitation equipment and simplifies construction of units.
- **Higher efficiency** . . . 96 percent or better overall, for most voltage applications.
- **Longer life** . . . no detectable aging of silicon cells has occurred even after many years of use.
- **Ease of installation** . . . units are completely factory-assembled. You need only make a-c and d-c connections.
- **Less space** . . . with new high-voltage silicon cells, maximum power can be built into the rectifier units with space savings up to 50 percent over previous designs. Your costs for buildings are lower.
- **No costly outages** . . . indicating equipment detects infrequent cell failure. Carefully planned design makes replacement of silicon cells simple and fast.

For full information on Westinghouse silicon rectifers for electrochemical applications, call your Westinghouse representative or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-15015

New 10,000-amp, 600-volt, d-c Westinghouse rectifier unit shown here allowed better than 50 percent space saving over the previous unit used in this type of service.



Typical high-power Westinghouse silicon rectifier cell, hermetically sealed for longer operating life and higher reliability.

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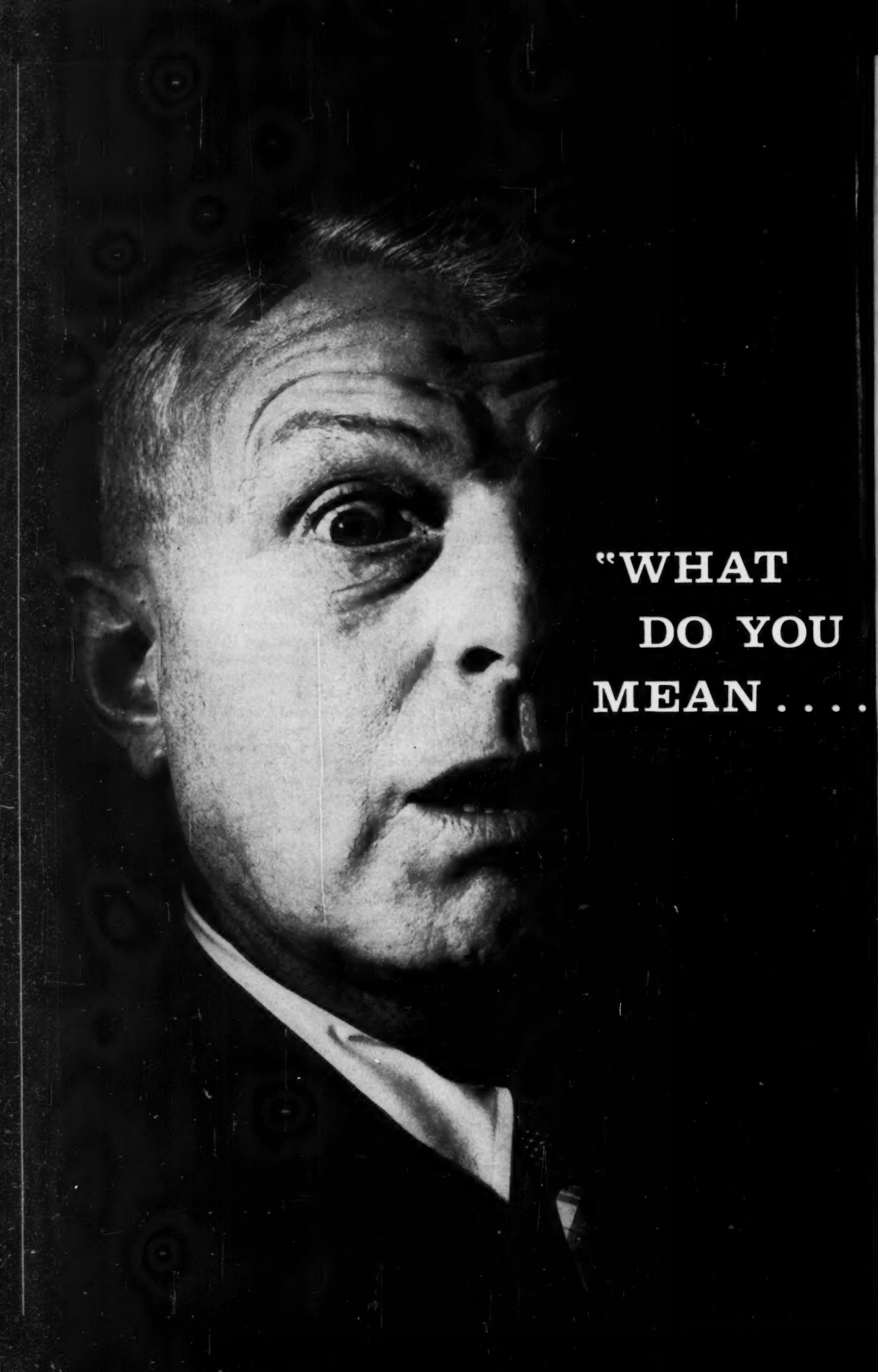
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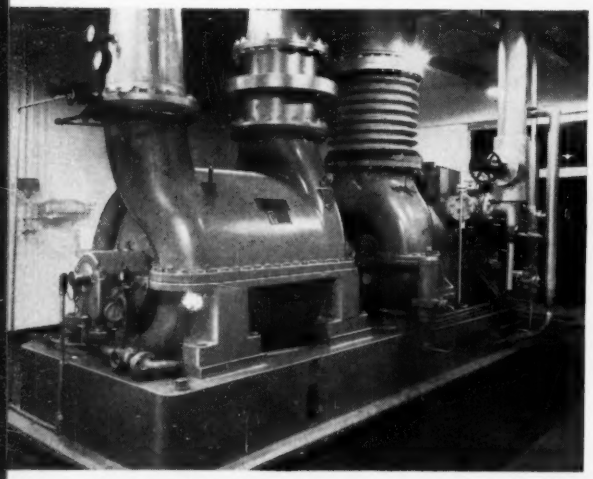
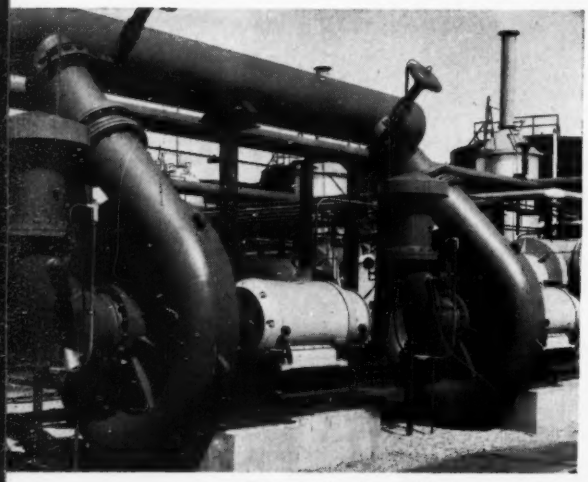
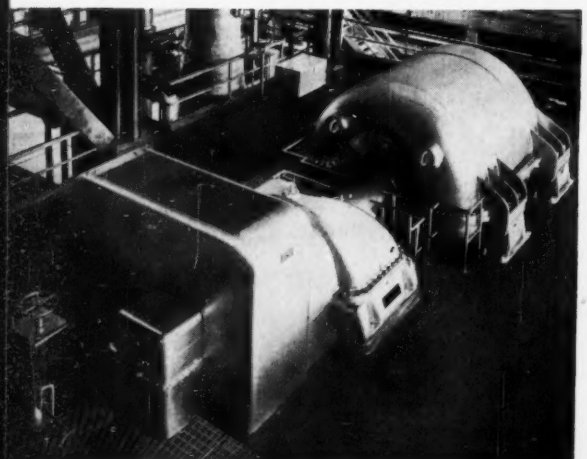


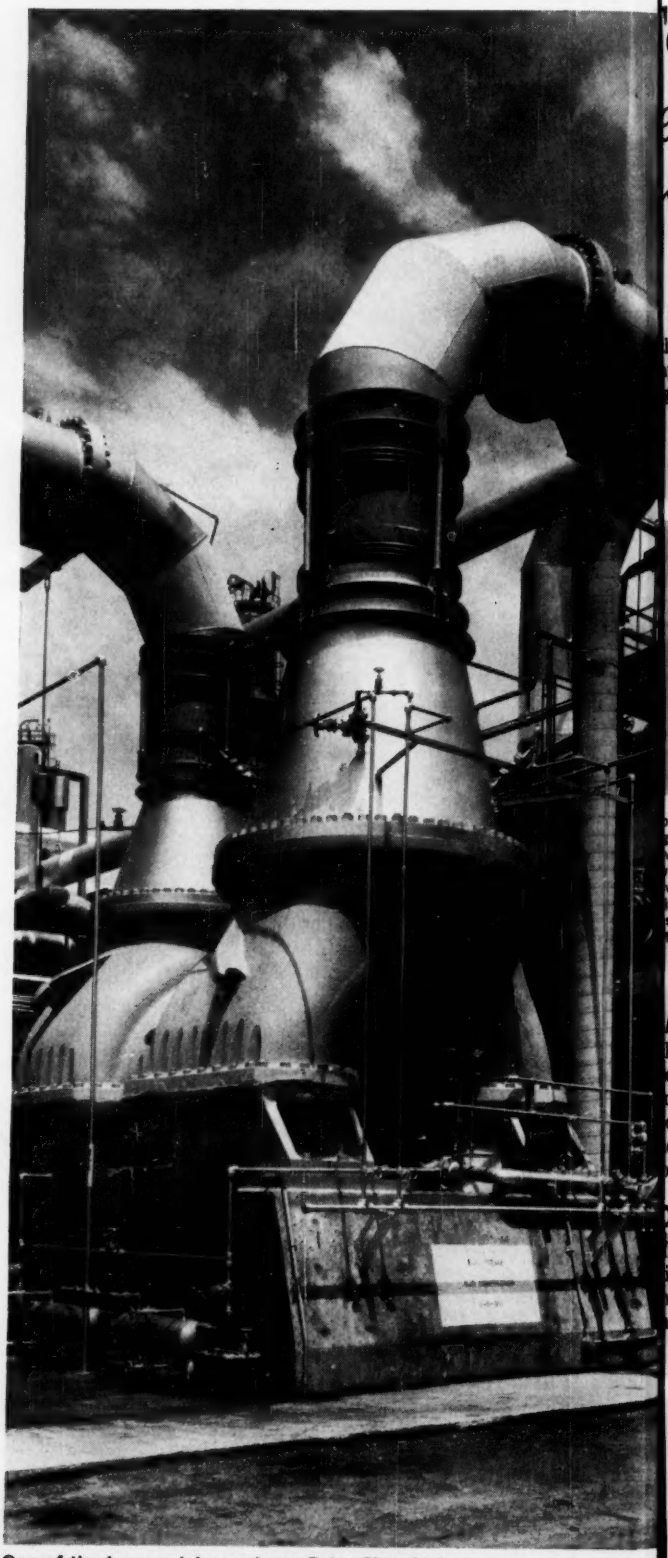
Elliott multi-stage compressor with 2035-hp Elliott turbine drive, in refinery service.



Two single-stage Elliott compressors driven by Elliott motors.



One of the largest turbine-driven multi-stage compres-



One of the large axials serving a Petro-Chemical plant.

T COMPRESSORS

loday's most complete line of entrifugal and axial machines rom **500** *cfm to* **600,000** *cfm*

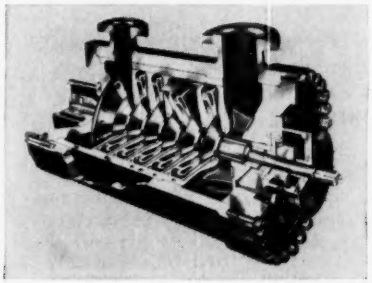
FRAME SIZES WITH MATCHING DRIVERS

h this, the most-complete line of centrifugal and axial pressors available today—Elliott offers an unexcelled e of choice of established machines. In addition, there is the extra advantage of matching Elliott turbine or motor drivers. Both units engineered and built by Elliott is a decided "plus" because it means unified responsibility, unified service.

SINGLE-STAGE COMPRESSORS

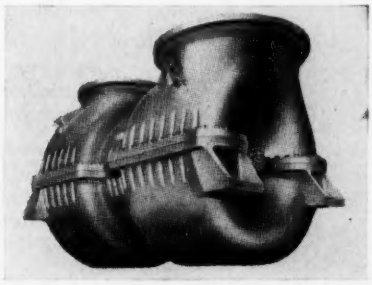
tt single-stage centrifugal compressors e in size from 700 to 100,000 icfm and ve. They are readily adaptable to special ice conditions, and to the handling of cor- ve or dirty gases. A variety of impeller gns, bearings, seals, and materials of struction permits each unit to be tailored s particular application.

MULTI-STAGE CENTRIFUGAL COMPRESSORS



Elliott multi-stage compressors are made in a wide variety of sizes and styles, to serve many difficult and exacting applications. They are available with inlet capacities up to approximately 150,000 icfm. Impellers, casings, internal passages and bearings for each type of machine have been designed to provide smoothly operating, rugged, dependable machines.

AXIAL FLOW COMPRESSORS



Multi-stage compressors of the axial flow type are designed and engineered specifically to serve the needs of industry for the handling of air or gas mixtures in large volume flow operation. Applications include petroleum refining, chemical processing and the steel industry. Frame sizes are rated up to approximately 600,000 cubic feet per minute when operating on air.

ATCHED MOTOR OR TURBINE DRIVE

liott is a leading manufacturer of both steam turbines d electric motors, of all types and ratings necessary to ovide driving power for the compressor units described ove. Consequently, we are in position to recommend d furnish the type of drive best suited for each applica- n.

OR AIR OR GASES

lliott integrated compressor units are available for han- ing all types of compressible fluids, within the pressure d flow limits of the machines. Where corrosive gases are ndled, special materials are employed in vulnerable spots; where high pressures are needed, extra heavy construction is used; where leakage must be prevented, special shaft seals are available; where high temperatures must be avoided, provision is made for cooling.

48 STANDARD FRAME SIZES

The total of 48 frame sizes permits accurate application for all compressor problems over the entire range of 500 cfm to 600,000 cfm. Pressures and speeds can be selected to meet the characteristics of the application, and the gas to be handled. *For further information, write Compressor Department, Jeannette, Penna.*

ELLIOTT THE MOST COMPLETE LINE OF **INTEGRATED COMPRESSOR & DRIVER UNITS** 500 cfm to 600,000 cfm

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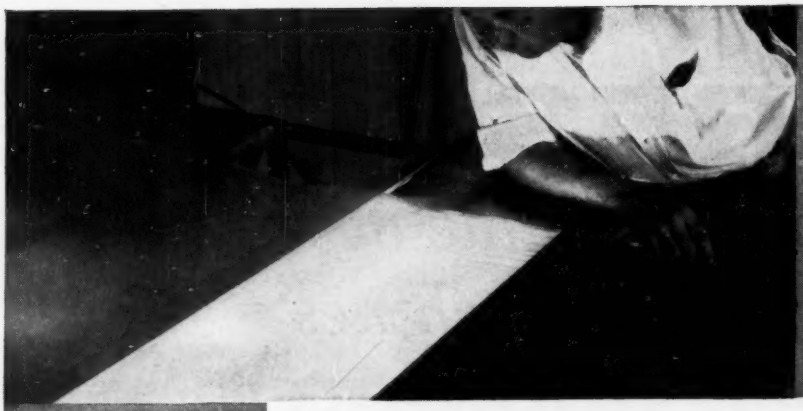

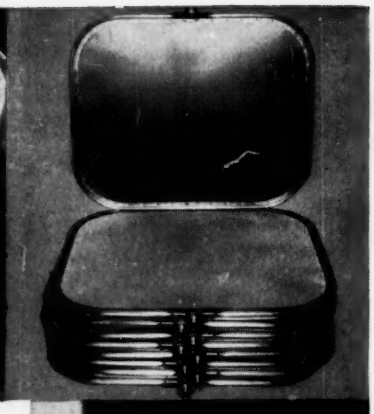

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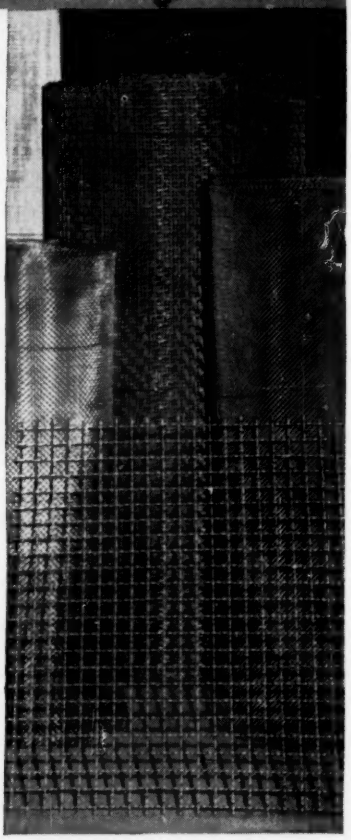
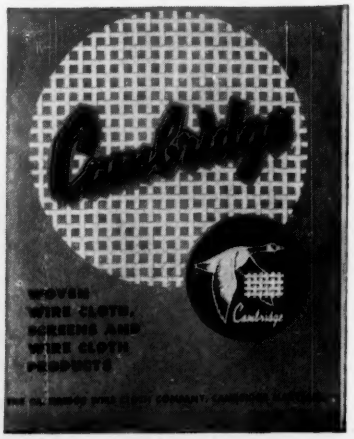
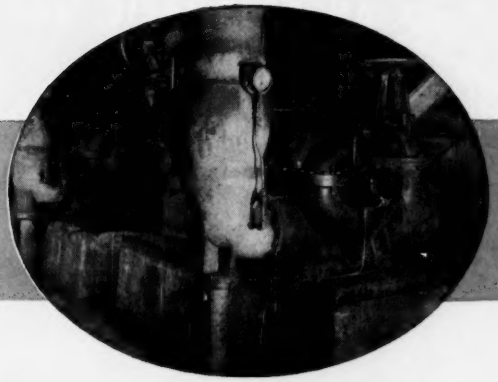




for the toughest pumping jobs . . .



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In paper mills, power plants, chemical and petroleum plants, mines, waterworks, manufacturing plants or wherever dependable, cost-saving pumping is a "must"—Ingersoll-Rand general service pumps continue to stand out in front.

These rugged pumps with horizontally split casings are suitable for a wide range of services for a variety of liquids. Single and two stage units are available for capacities to 4000 gallons per minute with heads extending to 1100 feet.

In 100 years of pump manufacturing, Ingersoll-Rand has solved innumerable liquid moving problems. If we can't meet your requirements from our extensive line of standard models, we'll engineer a unit just for you. Call the pump specialist at your nearest I-R branch or write direct to our New York headquarters.

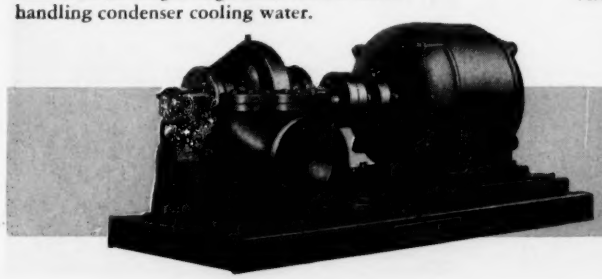
a century 1860 – 1960 *of pump progress*

from the leading manufacturer . . .

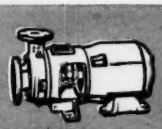
Ingersoll-Rand

76A9 **11 Broadway, New York 4, N. Y.**

This horizontally split unit is part of a line of pumps similar to the single stage units shown above handling condenser cooling water.



OTHER I-R PUMPS AVAILABLE



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New AN AUTOMATIC, COMPACT **LimiTorque**

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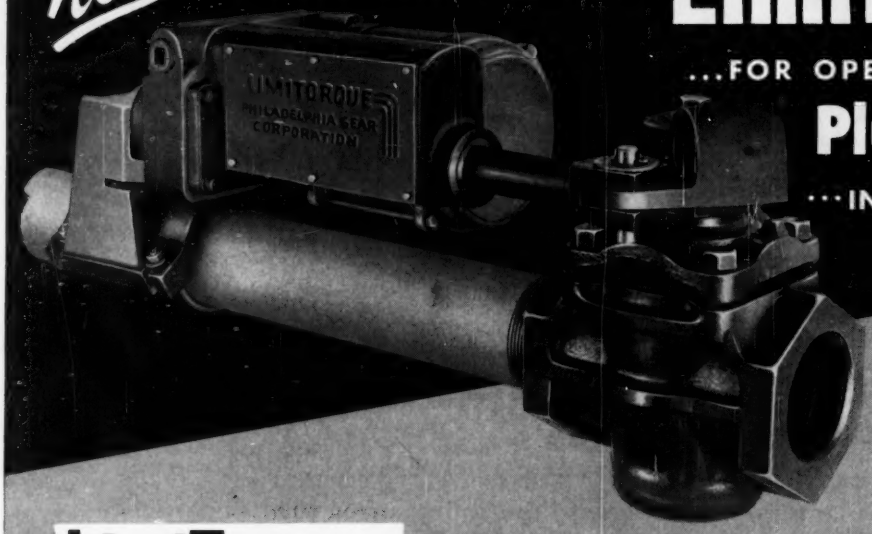
Plug Valves

...IN 8 TO 16 SECONDS



LimiTorque LINEAR MOTORIZED VALVE OPERATOR

...a dependable time, labor and money saver

Another LimiTorque *first* — here's the answer to the problem of motorizing your wrench (hand) operated Plug Valves . . . a simple, easily installed unit that can be built either to NEMA IV (weather-proof), or NEMA VII (explosion-proof) standards . . . an inexpensive, sturdy, fully reliable and extremely compact assembly that requires no gear changes or modifications, other than to supply a motor with the proper output speed. The *LimiTorque Linear Operator* consists of motor and double reduction gearing which drive a traveling screw and a crank that is easily mounted to the square shank of plug valve.

As noted in the illustrations, the entire assembly can be readily adapted to your plug valve while in service, by merely mounting the crank on the plug shank and strapping the support bracket to the pipe . . . The *Linear Operator* is supplied with all necessary adapting parts such as the support bracket and straps for mounting on the pipeline; also the necessary crank arm for mounting on the square shank of valve plug — The entire construction and operation is indeed simple . . . and the purchase price and installation costs are comparatively low.

A torque of 175# is developed at the valve, which is normally more than enough to drive most wrench-operated plug valves up to 6" in size. If power fails, or manual operation is desired, the mere removal of a pin (which connects the traveling screw to the crank arm) will divorce the crank from the *Linear Operator* assembly — and a bar placed in the bushed bore of the crank arm will operate the valve. (No special wrench is needed.) The mere flick of a switch to the direction of travel desired will operate the valve . . . Contact your valve manufacturer, or your nearest LimiTorque Sales Engineering Office.

Full details on this *new LimiTorque Linear Operator* are contained in Bulletin 20-58 . . . send for copy on your business letterhead.

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INDUSTRIAL GEARS & SPEED REDUCERS
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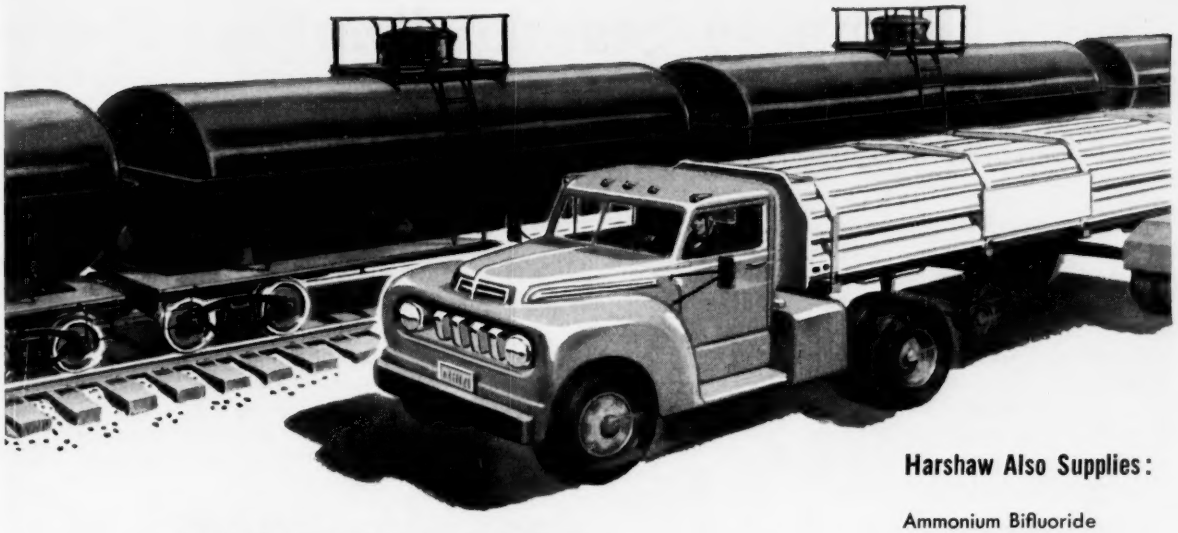

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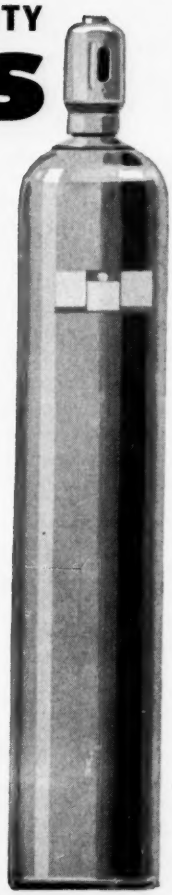

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Hydrofluoric Acid Aqueous
Hydrofluosilicic Acid
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Lead Fluoborate
Lithium Fluoride
Metallic Fluoborates
Potassium Bifluoride
Potassium Chromium Fluoride
Potassium Fluoborate
Potassium Fluoride
Potassium Titanium Fluoride
Silico Fluorides
Silicon Tetrafluoride
Sodium Fluoborate
Tin Fluoborate
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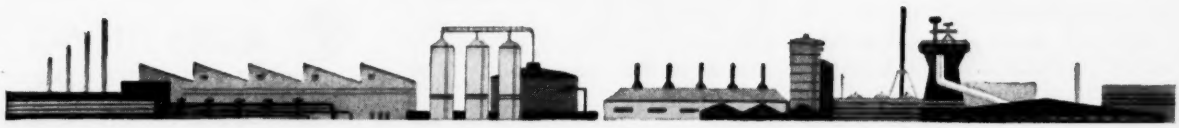
Zinc Fluoride

HARSHAW



Trapping Standardization

. . . steam trap standardization plus standardized hook-ups spell lower maintenance costs

An important weapon in the fight against rising maintenance costs is standardization. It can reduce the variety of maintenance problems and simplify those which remain.

Since we specialize in steam traps we'd like to offer some suggestions for a trapping standardization program. Such a program involves standardization on one make of trap and standardization of hook-ups.

Trap Standardization

The advantages of standardizing on a single make of trap are important and can make a big difference in the cost and ease of repairs because—

1. You can carry a more complete stock of repair parts with a smaller inventory.

2. Maintenance personnel has the opportunity to become expert on one make rather than be "jacks of all traps."

3. As an exclusive user of one make of traps you become a preferred customer of your trap representative and can be sure of getting the best possible service.

4. You can enjoy the advantages of standardized hook-ups.

Standardized Hook-ups

Standardized hook-ups facilitate and reduce the cost of both original installation and maintenance. By adopting standards for the dimensions of all fittings, including nipples, each hook-up for a given size of trap is identical and can be fabricated in the pipe shop.

Unions should be used so that when a trap needs repair, the unions can be uncoupled, the trap lifted from the line and a spare carrying identical length nipples and half unions slipped into place. In as little as a minute or two a faulty trap can be replaced. The faulty trap can go back to the storeroom for repair when convenient and then be put into stock as a spare.

Figure 1 shows a typical standardized hook-up used by a major chemical manufacturer. Note how

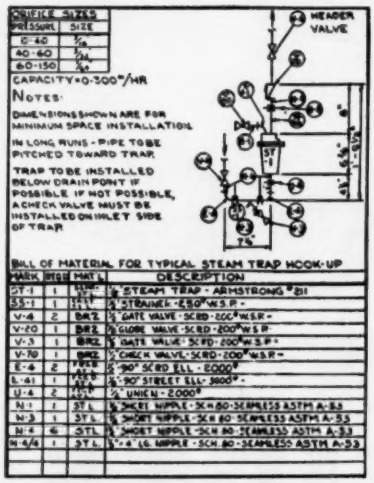

ORIFICE SIZES
PRESSURE
SIZE
0-40
1/8
40-60
3/64
60-150
1/16
CAPACITY=0-300#/HR
NOTES:
DIMENSIONS SHOWN ARE FOR MINIMUM SPACE INSTALLATION.
IN LONG RUNS - PIPE TO BE PITCHED TOWARD TRAP.
TRAP TO BE INSTALLED BELOW DRAIN POINT IF POSSIBLE. IF NOT POSSIBLE, A CHECK VALVE MUST BE INSTALLED ON INLET SIDE OF TRAP.
HEADER VALVE
BILL OF MATERIAL FOR TYPICAL STEAM TRAP HOOK-UP
MARK
ITEM
MAT'L
DESCRIPTION
ST-1 1 STEAM TRAP - ARMSTRONG #81
SS-1 1 STRAINER - 250# W.S.P.
V-4 2 BRZ. GATE VALVE - SCRD - 200# W.S.P.
V-20 1 BRZ. GLOBE VALVE - SCRD - 200# W.S.P.
V-3 1 BRZ. GATE VALVE - SCRD - 200# W.S.P.
V-70 1 BRZ. CHECK VALVE - SCRD - 200# W.S.P.
E-4 2 FMSI 90° SCRD ELL - 2000#
L-41 1 FMSI 90° STREET ELL - 3000#
U-4 2 FMSI UNION - 2000#
N-1 1 STL CLOSE NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-3 1 STL CLOSE NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-4 6 STL CLOSE NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N 4/4 1 STL 4" LG NIPPLE - SCH 80 - SEAMLESS ASTM A-53

Fig. 1—Typical standardized installation hook-up used by a leading chemical manufacturer.

the hook-up provides the following advantages:

1. Test valve in trap cap permits fast, easy checking of trap operation.

2. Strainer ahead of trap protects it against dirt and scale.

3. Blowdown valve in strainer provides easy cleaning.

4. Check valve in discharge line isolates trap when test valve is opened.

5. Shut-off valves and unions ahead of and following trap permit removal of entire trap from line.

Fig. 2—Armstrong traps have only two moving parts—the lever assembly and the bucket. Nothing much to go wrong here.

Another important consideration for getting the most from a standardization program is accessibility of the traps. Insofar as is possible, traps should be located so that they are convenient for inspection. The easier it is to locate and get at a trap, the less likelihood that it will be overlooked.

What Make of Trap? (This is the Commercial)

Obviously, a trap standardization program shows the best results when the make of trap selected is the one that gives the best service. Naturally, we think the make should be Armstrong and fortunately a lot of trap users agree. Here are some of the advantages of standardizing on Armstrong that have been pointed out by these users:

1. *Armstrong traps work.* They don't leak steam and they do discharge condensate and air as fast as they reach the trap. And they work with any return system.

2. *Armstrong traps aren't "prima donnas."* They need no special care or coddling. Valve and seat are hardened chrome steel. Lever assembly and bucket are stainless steel and these are the only moving parts.

3. *Armstrong traps aren't "orphans."* You can *always* get parts and service from nearby Factory Representatives and stocking distributors.

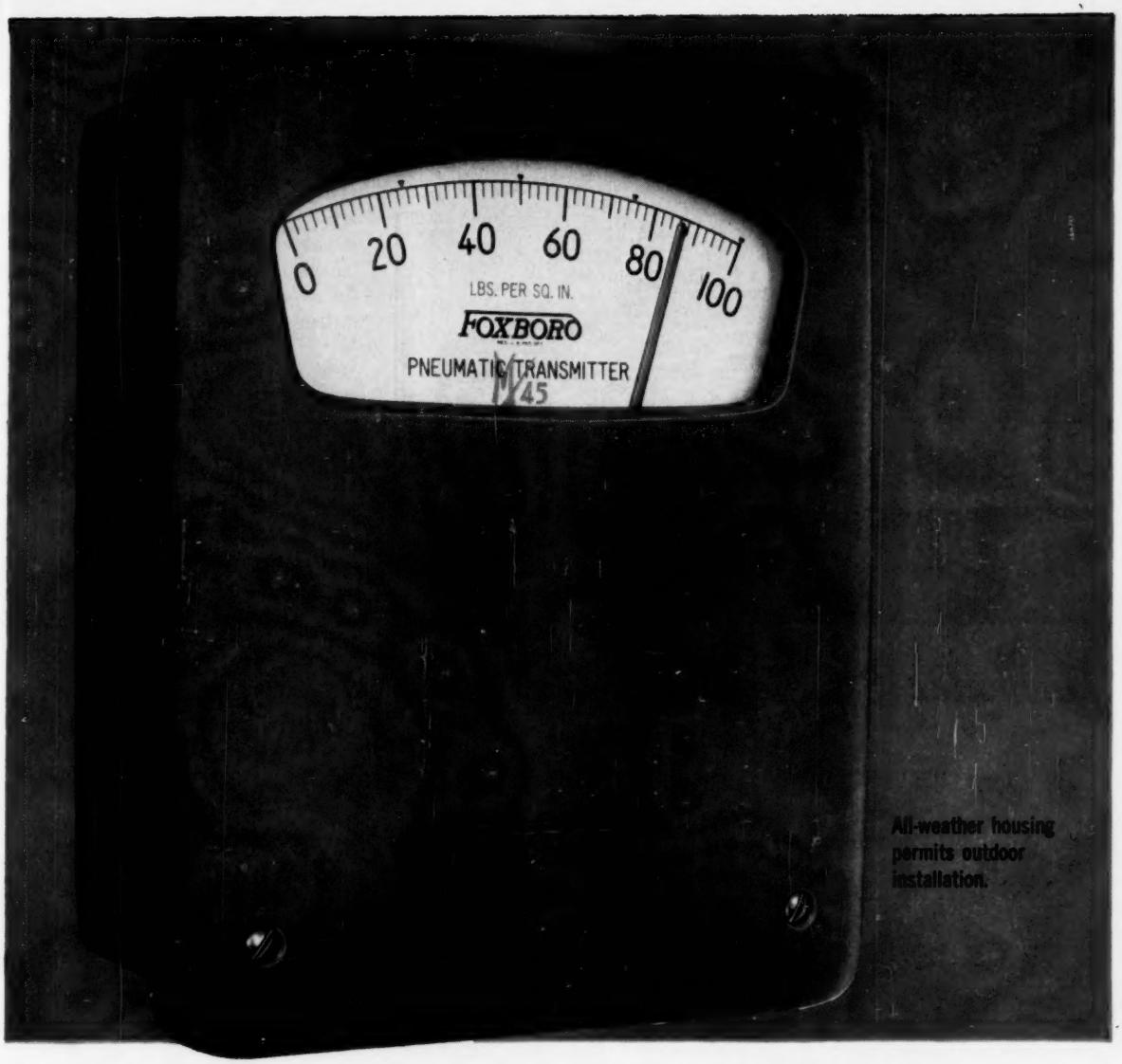
4. *Armstrong traps are guaranteed.* If you're not *completely* satisfied you can return the traps for refund of purchase price.

More Information

The 44-page Steam Trap Book (free on request) gives a lot more facts on trap selection and installation. Call your local Armstrong Representative or write **Armstrong Machine Works, 8581 Maple St., Three Rivers, Michigan.**

ARMSTRONG STEAM TRAPS

See Our Catalog in Chemical Engineering Catalog



You can use this new Foxboro pneumatic transmitter on six different process measurements

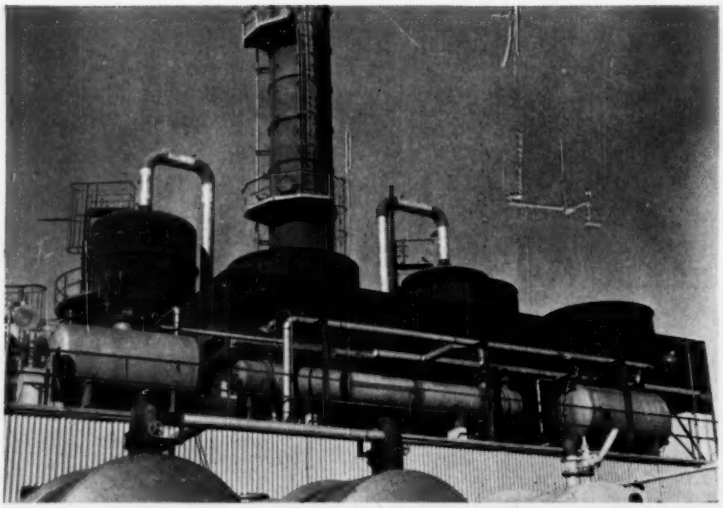
pressure – temperature – liquid level – differential pressure – dew point – flow... all six with guaranteed accuracy of ±½ of 1%

Think of it . . . a universal pneumatic transmitter with matched elements for six different process variables. That's the new Foxboro M/45 pneumatic indicating transmitter.

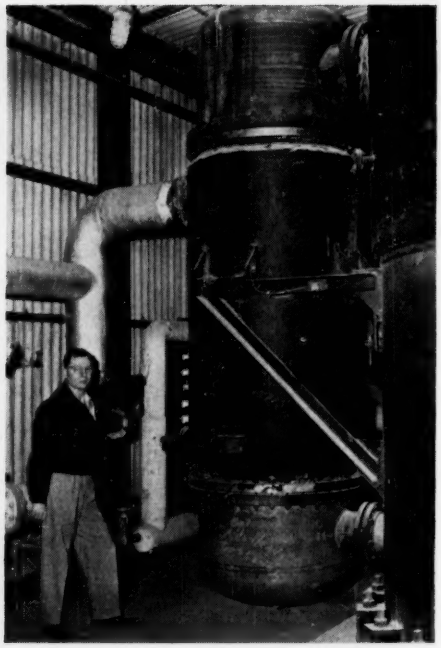
And with the M/45 you get: *universal* high accuracy-guaranteed at ±½ of 1%; *universal* ambient temperature stability — less than ½ of 1% in 50°F temperature change; *universal* calibration and simplicity of servicing. A remarkable combination of versatility and uniformity in a single instrument.

The new Foxboro M/45 indicating transmitter can extend the benefits of standardization throughout your whole plant operation. Ask your Foxboro field engineer to tell you about it. Or write for Bulletin 13-30. The Foxboro Company, 365 Neponset Ave., Foxboro, Mass.

FOXBORO
REG. U.S. PAT. OFF.



To process acetic acid...
(240 million lbs. a year)



Carpenter Stainless Heat Exchanger Tubing

• In this case, Carpenter austenitic tubing was specified for handling acetic acid in concentrations up to 99.5%. Chromium in the steel develops a protective oxide surface film which resists corrosion. The formation of this corrosion resistant film is dependent upon a clean, smooth surface free of imperfections, dirt or scale on the tube surface. That's why dependable Carpenter Stainless Tubing . . . known for its fine *finish* as well as its other anti-corrosive characteristics . . . was used.

Carpenter Stainless Heat Exchanger Tubes meet ASTM Spec. A-249. But, more important, they must also pass the most searching non-destructive tests applied to stainless tubing anywhere. This intensive Carpenter quality control is your assurance of dependable performance and fabricating economies on any heat exchanger application.

For technical help or fast mill stock delivery, call your Carpenter representative today. The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

your master key to cost-savings in chemical processing

Carpenter

Stainless Tubing & Pipe

Higher output on FINE GRINDING..20 to 400 mesh.. with WILLIAMS ROLLER MILLS

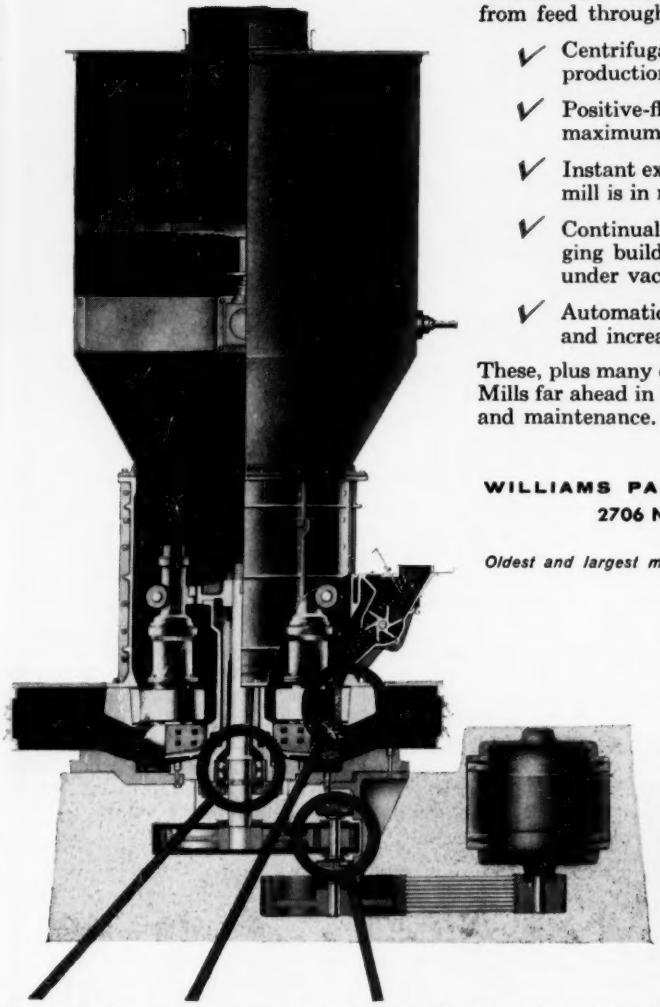
A Williams does the entire job in a single continuous operation—from feed through grinding, blending, drying and classifying!

- ✓ Centrifugal grinding roll action against bull ring keeps production high—automatically compensates for wear
- ✓ Positive-flow feed control is self-adjusting—maintains maximum capacity of mill
- ✓ Instant external fineness adjustment can be made while mill is in motion
- ✓ Continual upward air sweep to classifier prevents clogging build-up of finely ground material. Mill operates under vacuum to insure dustless operation.
- ✓ Automatically controlled hot air is available for drying and increased output of moist material.

These, plus many other advanced features keep Williams Roller Mills far ahead in higher production, lower costs. less downtime and maintenance. *Write for catalog.*

WILLIAMS PATENT CRUSHER & PULVERIZER CO.
2706 North 9th Street • St. Louis 6, Mo.

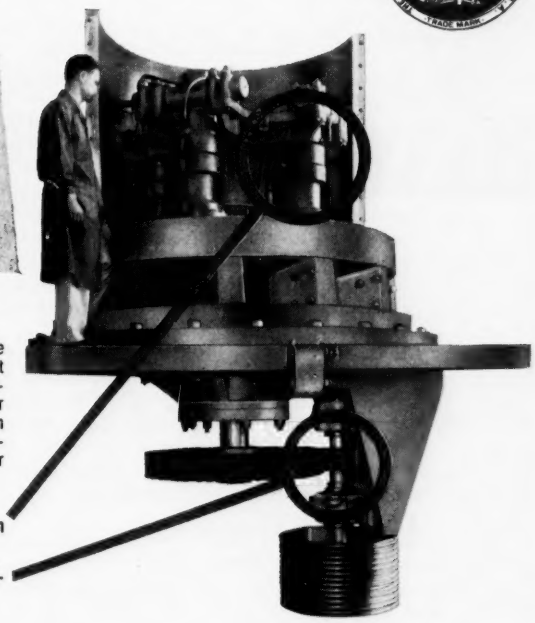
Oldest and largest manufacturers of hammer mills in the world



Troublesome alignment is greatly simplified and far less frequent with only 2 bearings on main shaft; the bottom one carrying both radial and thrust loads.

From here, material pulverized by rollers against bull ring are airlifted to classifier which passes correctly sized product and returns coarse material for regrinding.

Exclusive! Only Williams has longer-life SPUR GEAR or GEARLESS DRIVES that eliminate expensive bevel and other hard-to-maintain gears. Standard and larger models have rugged spur gear and pinion drive—smaller models have direct motor-to-shaft V-belt drive requiring no care or lubrication.



"Giant" mill with cover section off show roller journals which suspend grinding rolls on bearings sealed against dirt and grit. Note wear-resistant steel forged bull ring.

Housing is also removed to show rugged spur gear and pinion drive. Easy, quick accessibility for service is another Williams time and money-saving feature.

WILLIAMS
CRUSHERS GRINDERS SHREDDERS

Hammer Mills | Helix-Seal Mills | Air Separators | Vibrating Screens | Feeders | Impactors

Why Solar designs industrial gas turbines to weigh between 1 and 1½ lb/hp

by Paul A. Pitt
Chief Engineer
Solar Aircraft Company

The weight of Solar gas turbines is the result of a design philosophy that is unique in the small gas turbine field.

Most gas turbine designs fall into one of two extreme categories. Aircraft-type engines, at one extreme, embody highly sophisticated techniques for extreme light weight in relation to horsepower, but have resulting short life. The opposite philosophy employs the ultra-massiveness of steam turbines to assure long life.

There are important disadvantages in both approaches when long life, reasonable cost, dependable operation, simple maintenance and easy transportation and installation are required. While aircraft-design engines (of ¼ to ½ hp/lb) can be modified and derated for longer service life, the resulting product is inherently delicate. This compromise inevitably results in short life.

Paul A. Pitt

On the other hand, massive design (of 10 lb/hp and up) leads to unnecessary structural bulk and introduces problems of thermal lag and distortion.

Since World War II, Solar has designed and built a variety of gas turbine units with characteristics that lead to both long life and low weight. The Saturn gas turbine engine, for example, is an 1100 hp unit intended specifically for industrial and military installations. It has a weight-to-power ratio of 1.1 to 1.4 lb/hp.

Although it is designed for long life, it utilizes only enough materials in its components to satisfy structural and thermal requirements. This approach resulted in a design that makes no compromises with durability and performance, yet meets the needs of industry for flexibility in a small package. It has an 1100 hp rating at a specific fuel consumption of 0.61 lb/hp-hr and a continuous rating of 1020 hp at 0.63 lb/hp-hr SFC.

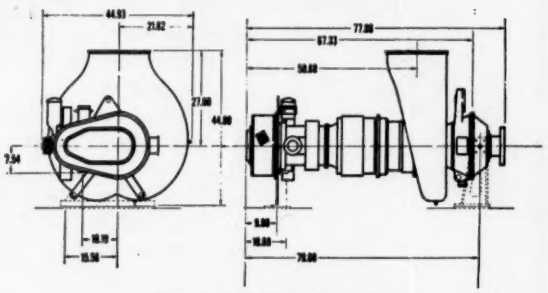
Meeting these objectives required an engine with a simple thermodynamic cycle and high efficiency components. An axial compressor was designed with an operating efficiency of 86%, and this was combined with a multi-stage, axial type turbine of advanced aerodynamic design. Over-all dimensions of the engine are shown in the figure below.

To fulfill workhorse service requirements, the engine was designed to operate at a conservative gas temperature of 1450 F continuous rating. The stress levels are also low, so that major rotating and stationary components will have more than 100,000 hours of life with long periods between overhaul. To keep costs down and assure dependability, the engine design is simple and straightforward.

In brief, the development program of the Saturn turbine adhered to three principles: Careful aerodynamic design for high performance; use of moderate temperatures and low stress levels for long life; and exhaustive component testing for ruggedness and reliability.

Presently scheduled field applications of the Saturn turbine include: Power source for 750 kw electric generator sets in process plants, portable field equipment, pipeline pumping, and gas compression in the petro-chemical industry. Other uses are as a power source for a 600 kw generator set in a commercial marine installation, propulsion units for marine and amphibious vehicles, and prime movers for off-highway vehicles.

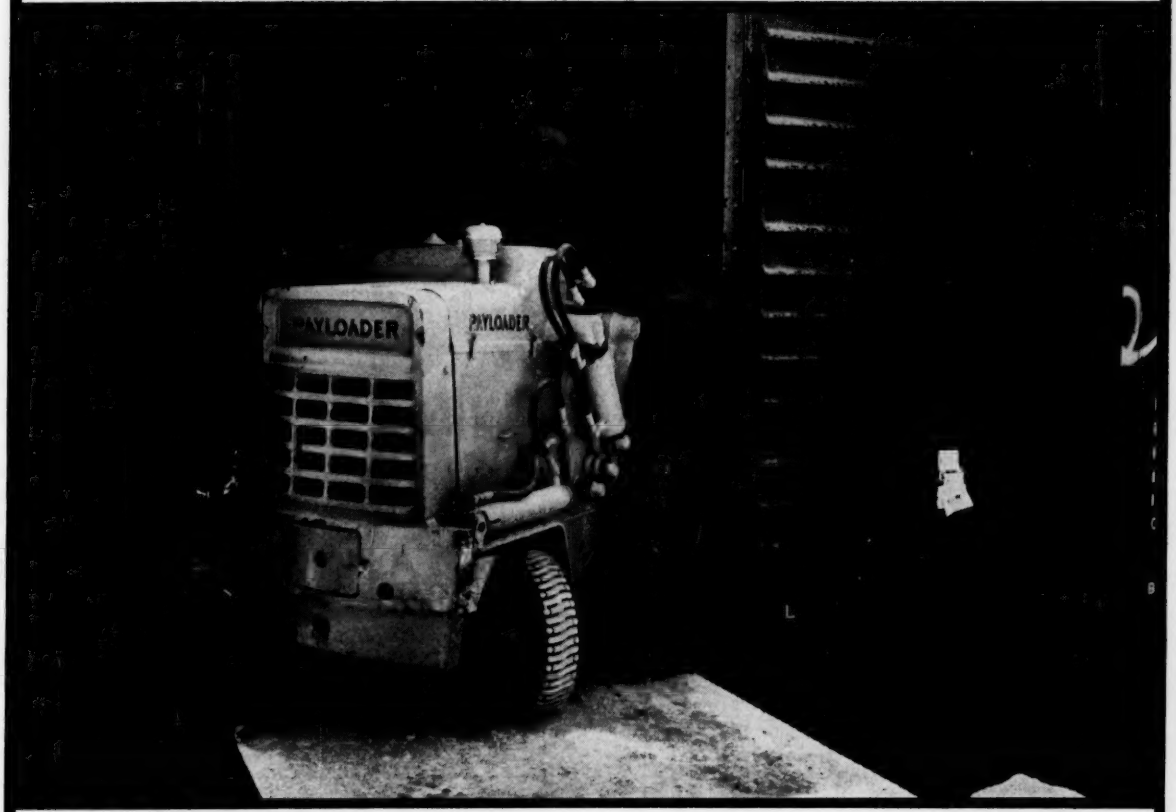
Detailed data on Solar gas turbines and other turbomachinery is available. Write Dept. H-118, Solar Aircraft Company, San Diego 12, California.



Saturn T-1000 dimensions

SOLAR
AIRCRAFT COMPANY

PAYLOADER® is more productive



because it's more maneuverable

Never before has so much carry capacity, ease of operation and short-turning ability been combined in a tractor-shovel. That is why the model H-25 "PAYLOADER" is setting new tonnage records on boxcar unloading and other close-quarter work. "No machine you can put in a boxcar is as good as a HOUGH," says Bob Freun of Fruen Fertilizer, Hatfield, Minn.

It digs and carries 2,500 lbs. low and close with good balance and fullest operator visibility. Power-steering and only 6-foot turning radius, power-shift transmission with torque-converter drive, and powerful hydraulic brakes all assure the operator of safe, easy and accurate control. He can maneuver around corners, through narrow aisles, doorways and crowded yards, up and down ramps with speed and safety.

Your Hough Distributor is ready to show you how the H-25 can increase output at lower cost on your bulk-handling work. Contact him today or use the coupon below.

These features give low-cost bulk handling

2,500 lbs. carry capacity • Only 6-foot turning radius • Power-shift transmission • Power steering • Power-transfer differential • 40° bucket tipback at ground • 4,500 lb. bucket breakout force • Fullest mechanical protection • Useful extra attachments

HOUGH®

THE FRANK G. HOUGH CO.
LIBERTYVILLE, ILLINOIS
SUBSIDIARY — INTERNATIONAL HARVESTER COMPANY

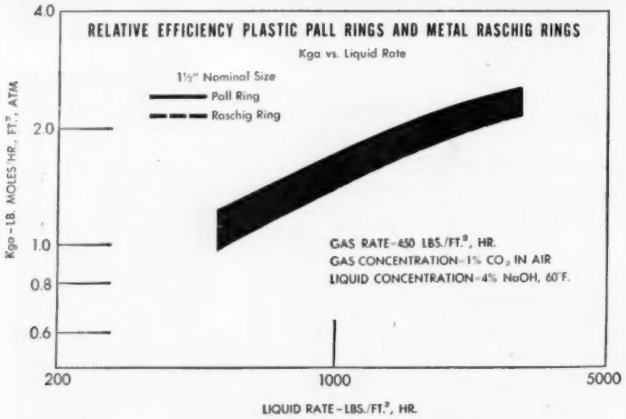
11-A-1

THE FRANK G. HOUGH CO.
734 Sunnyside Ave., Libertyville, Ill.

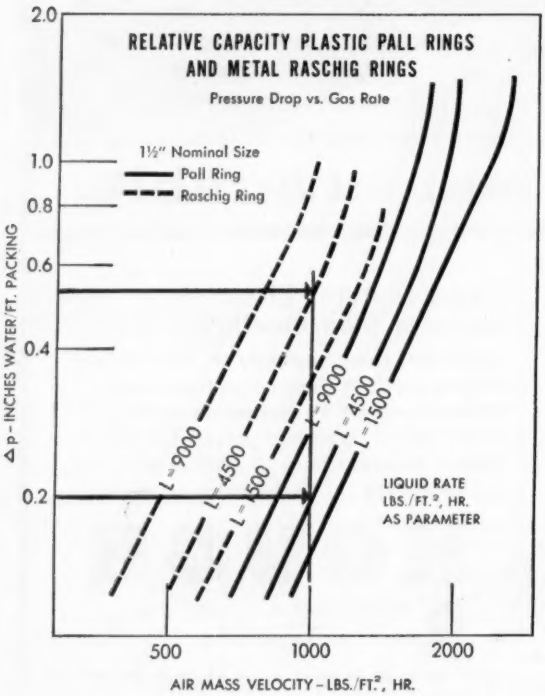
☐ Send data on H-25 "PAYLOADER"
☐ Other models to 12,000 lb. carry capacity

Name _____
Title _____
Company _____
Street _____
City _____ State _____

NOW PALL RINGS in PLASTIC



Kga data, obtained in one of our 30" experimental towers, reflects the much greater efficiency of plastic Pall Rings.



Pressure drop data likewise reflects the high capacity of plastic Pall Rings. For example, pressure drop through metal Raschig Rings at a gas rate of 1000 lbs./ft.², hr., and a liquid rate of 4500 lbs./ft.², hr., is almost three times greater than through plastic Pall Rings.

The remarkably efficient Pall Ring, first introduced on the American market in 1957, in metal, is now available in polypropylene and high density polyethylene;* in four sizes: 5/8", 1", 1½" and 2".

Pall Rings in plastic offer the same striking advantages of low pressure drop and high capacity at less than one-fourth the weight. (For example, 1½" Pall Rings in carbon steel weigh approximately 23½ lbs. per cu. ft. In plastic, only 4¼ lbs.)

Take a look at the graphs showing comparative efficiency data and capacity data for metal Raschig Rings and plastic Pall Rings . . . data prepared from test runs in one of our 30" diameter experimental towers. The differences stem entirely from the characteristics of the two rings. In the Pall Ring the inner projections of the wall become active working surfaces as opposed to the relatively "dead" inner wall of the Raschig Ring.

The conclusions are inevitable: tower volume can be substantially reduced by using Pall Rings (either metal or plastic) in place of Raschig Rings.

***On special order, Plastic Pall Rings can also be supplied in PVC and polystyrene.**

U. S. STONEWARE

AKRON 9, OHIO

NEW YORK • CHICAGO • HOUSTON • LOS ANGELES

05-G

DEVELOPMENTS . . .

MAY 30, 1960

Chementator

T. PETER FORBATH

Shell Chemical has tripled its planned polyisoprene output. The 40-million-lb./yr. plant at Torrance, Calif., due for startup in fall will be joined by an 80-million-lb/yr. facility at an undisclosed Midwestern location in late 1961.

Arvin Industries has developed "novel catalyst" for removing smog-forming hydrocarbons from auto exhausts. Too, Union Carbide is testing anti-auto-smog system that teams catalytic oxidation and direct combustion to burn about 90% of exhaust hydrocarbons and carbon monoxide.

Allied's Barrett Div. has developed process for recovering gypsum byproduct of wet-process phos acid plants. Material, rated as good as that found in highest purity rock deposits, will be feed for new wallboard plant at Claymont, Del.

Ch.E.: Top paid technical man?

Are chemical engineers—along with doctors of medicine—the best paid of all scientific and technical personnel?

Yes, declares the National Science Foundation's just-released Salary Profile of the National Register of Scientific and Technical Personnel (1956-58). According to this study, which surveyed some 137,000 scientists and engineers of which 4,759 were chemical engineers, Ch.E.'s earn median annual pay of $10,436. Only MD's of all other scientists and engineers listed in the National Register, top them with an annual median salary of $10,872.

Using a four way breakdown—by field, function, degree and age group—NSF, in cooperation with eight professional societies and the U. S. Public Health Service, has come up with these data on Ch. E.'s:

- Highest paying fields are industry and self-employment ($10,442/yr.) with non-profit organizations ($9,682/yr.) and the federal government ($9,523/yr.) running close seconds.
- Ch.E.'s in management earn around $14,000/yr.; in research, development or design, just under $9,000/yr. Median for all other functions runs roughly $9,700/yr.
- Ch.E.'s with doctorates post annual median earnings of $11,637/yr.; with masters, $9,932/yr.; with bachelors, about $9,818/yr.
- Ch.E.'s between 20 and 30 earn median wage just under $7,000/yr.; between 50 and 60, over $15,000/yr.

Shelf of standards comes tumbling down

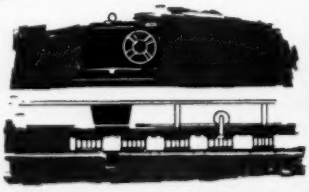
Esso Research and Engineering has drastically revised the engineering standards and purchase specifications that it has been using as the basis for all its plant construction during the last 30 years.

Behind the move: Esso's new view that standards should only outline what results are to be sought in plant construction, not how

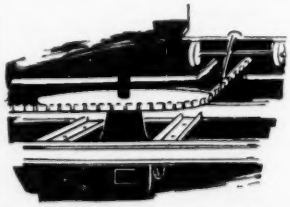
FAST off-the-shelf delivery

MORSE EBERHARDT-DENVER CONVEYOR DRIVES

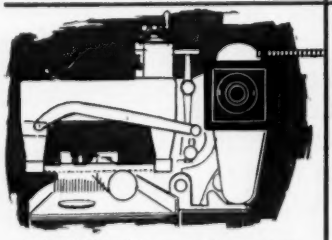
★ No design limitation . . . up, down, or 90° mounting ★ one-piece alloy cast iron housing ★ high torque capacity ★ single or double reduction gears ★ input ratings from .12 hp to 53.72 hp using double worm reduction or helical worm reduction ★ ratios from 5:1 up to 3600:1—from stock at low factory prices.



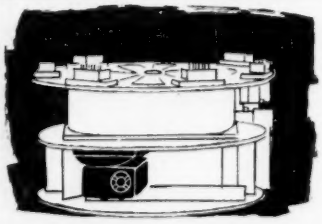
OVERHEAD . . . typical caterpillar or sprocket drives



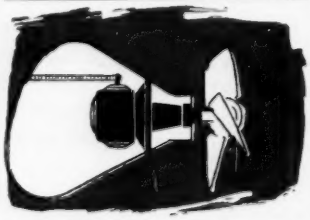
SUB-FLOOR . . . for towline or special equipment



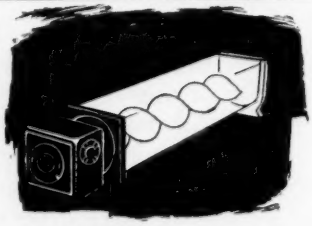
90° MOUNTING . . . for heavy-duty metal saws and machines



VERTICAL . . . base mounting for power turntable machines



SIDE MOUNTED . . . paint, pulp, liquid, or chemical agitators



HORIZONTAL . . . screw conveyors, straight or angular mounts . . . and scores of standard or special uses.

Easy-mount design . . . only 4 bolts

Morse E-D speed reducers lead in limitless applications with utmost ease in mounting. The 4 holes form a perfect square concentric to the output shaft. Unlike most designs, Morse E-D speed reducers feature oversize bearings on wide centers . . . resulting in an overhung load capacity at the end of the output shaft equal to the torque capacity.

Mounting versatility with the unit's cast-in base makes Morse drives adaptable to conveyors of all types, agitators, screw conveyors, machines, and for any other transmission of power where dependable speed reduction is specified.

You'll find Morse "standard" drives ready for immediate delivery . . . often eliminate the problems of "specials." Check with your Morse distributor, he's listed in the Yellow Pages under "Power Transmission," or write Morse Chain Company, Dept. 42-50, Ithaca, N. Y. for illustrated catalogs. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ontario.

MORSE BW

A BORG-WARNER INDUSTRY

they're to be achieved. Result: Company has junked its widely known "shelf of volumes" that spell out virtually every last nut-and-bolt detail on over 300 aspects of plant design and engineering. In its place now stands a single, slim book, titled Esso Basic Practices, that sets forth simply the minimum requirements, in terms of end results, to be met in the construction of Esso manufacturing facilities.

Esso's new abridged standards program is designed to "stimulate greater creativity in contractors' engineering and procurement work, give them greater freedom to take advantage of local conditions and greater latitude in utilizing their own techniques and know-how." Result, Esso believes, will be more economic facilities.

Currently, over 1,200 sets of the original standards, which during the past ten years have served as the Bible on some $3-billion worth of Esso construction jobs, are in the process of being exchanged for the new volume.

New welding technique opens Ti markets

Titanium is hitting the comeback trail. After years of near oblivion, this pioneer "atomic-age" metal now has markedly improved hopes of winning substantial markets as a construction material in chemical process equipment. Reason: Adding to its steadily diminishing price (from $5/lb. sponge in '54 to $1.60 now) and its excellent corrosion resistance are new techniques being developed for fabricating with titanium.

Last month Titanium Metals Corp. of America unveiled a new process for welding titanium to carbon steels. Joining the two metals through an inter-layer weld of vanadium, TMCA's new technique permits construction of steel process vessels with "extremely" thin-gage—thus low-cost/sq.ft.—titanium linings. F. W. Glitsch & Sons, Dallas, Tex., equipment fabricator, reportedly intends to adapt scheme, offer Ti-lined steel production equipment in near future.

Development follows closely word of a similar process. Late last year (*Chem. Eng.*, Nov. 2, 1959, p. 118), Chicago Bridge & Iron reported that it was prepared to build large Ti-clad vessels by using a silver inlay to join titanium to steel.

Both of these techniques succeed in a once-impossible task by skirting need of joining titanium directly to steel. Though technically feasible, a direct Ti-steel joint is so extremely brittle as to be virtually useless. But either a Ti-vanadium-steel weld or a Ti-silver-steel braze reportedly makes for a first-rate joint.

Outstanding feature of TMCA's scheme, according to the company, is that it permits vessels to be lined with exceptionally thin-gage titanium sheet. And the thinner the gage, the cheaper the liner. Claims TMCA, vessel linings thinner than 0.01 in. are now possible, cost under $4/sq.ft. Previously Ti linings of 0.062 in. were regarded as about the thinnest possible, cost roughly $12.75/sq.ft. As a result, TMCA believes that Ti-lined vessels can now compete with brick- and rubber-membrane-lined vessels for corrosion service, especially in handling wet chlorine where Ti "has no corrosion-resistance equal."

Sixties open to sustained spending

Latest look at capital investment plans—McGraw-Hill's 13th annual survey—reveals that business will spend even more on capital goods in 1960 than it had thought. Preliminary plans (*Chem. Eng.*, Dec. 28, 1959, p. 36) showed that all manufacturers would spend 19% more than in 1959. Now it appears that the increase will be 26% over last year, to $15.24 billion.

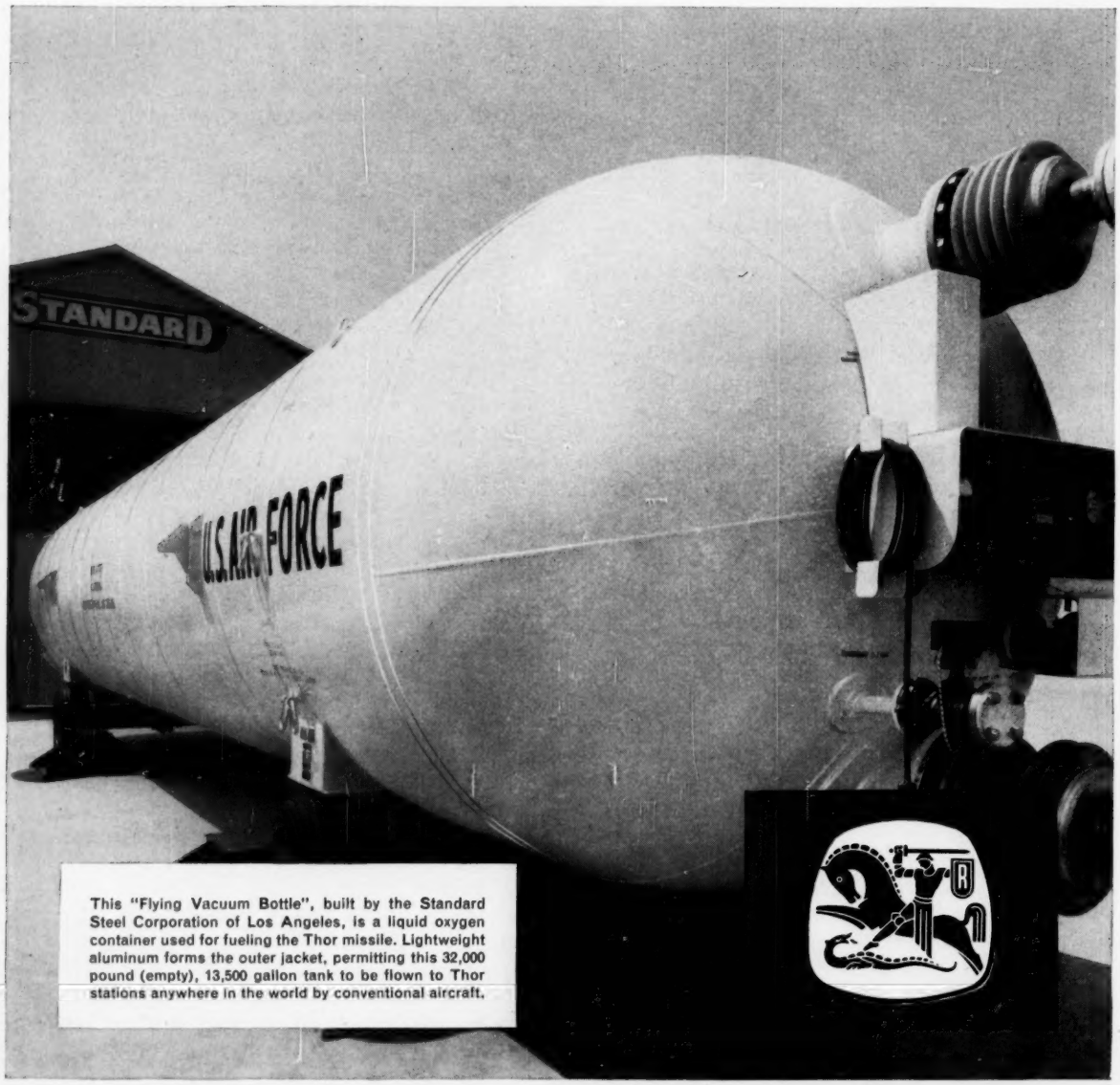
Boosting the surge of expenditures for new plant and equipment are segments of the chemical process industries. Chemicals are up 38% to $1.7 billion; paper and pulp up 25% to $0.8 billion; rubber up 40% to $0.3 billion; stone, clay and glass up 31% to $0.7 billion; petroleum refining up 5% to $0.8 billion. And preliminary plans for 1961-63 indicate that industry may continue high investments throughout the decade, with $14.2 billion in '61; $13.3 billion in '62; $13.6 billion in '63.

Increase in investment in the CPI will not be matched by comparable increase in capacity, however. According to McGraw-Hill's Index of Industrial Capacity, chemical capacity increase for 1959-60 will be same as for 1958-59—5%. Stone, clay and glass capacity increase will be up ('58-59: 4%; '59-60, 6%). But paper and pulp capacity increase will drop ('58-59: 6%; '59-60: 3%) as will rubber ('58-59: 7%; '59-60: 5%) and petroleum refining ('58-59: 2%; '59-60: 1%). Latter category will continue to increase capacity at slow rates compared with the rest of manufacturing—

(Continued on page 38)

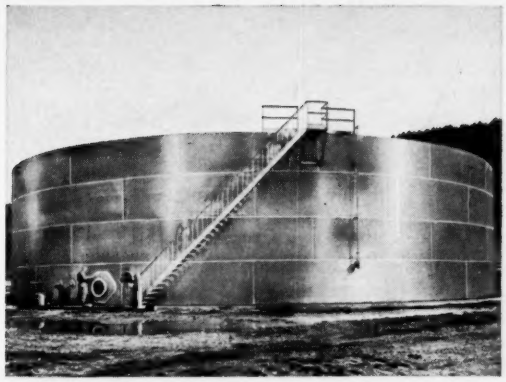
Aluminum Tanks and Vessels cost far less

...than those made with other corrosion-resistant metals!

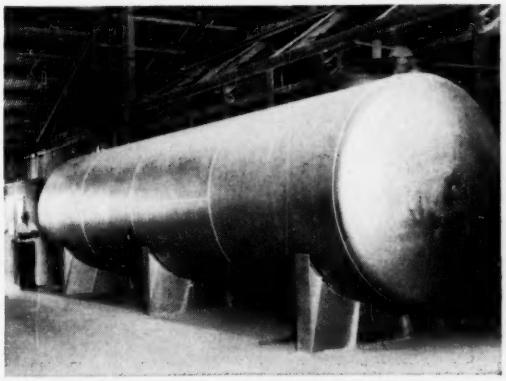


This "Flying Vacuum Bottle", built by the Standard Steel Corporation of Los Angeles, is a liquid oxygen container used for fueling the Thor missile. Lightweight aluminum forms the outer jacket, permitting this 32,000 pound (empty), 13,500 gallon tank to be flown to Thor stations anywhere in the world by conventional aircraft.

The major costs of tanks or vessels are for initial materials and subsequent maintenance—and aluminum is the one corrosion-resistant alloy that offers big savings in both. It is corrosion-resistant in most atmospheres and, it's easy to keep clean. Yes, aluminum costs less, far less, and here are more reasons why:



This giant aluminum tank holds ammonium nitrate solution. Non-sparking aluminum gives extra-long service under constant exposure to corrosion, with a minimum of maintenance.



Highly corrosive nitrogen solutions are safely stored in this tank made of Reynolds Aluminum for quick, local service to farmers for use in soil treatment.

CORROSION-RESISTANT

Aluminum resists corrosion from most process liquids. *Hydrogen peroxide, petroleum products, acetic acids, nitric acids, nitrogen solutions, turpentines, lacquers, beverages, sulphur-bearing gases*—all, and many other corrosives, can be handled in aluminum tanks and vessels without contamination or corrosion. Climatic conditions and atmospheric gases normally do not affect aluminum. Flammables may be safely stored in aluminum tanks and vessels, for aluminum is non-sparking.

LIGHTWEIGHT

Aluminum weighs just one third as much as steel. This can often mean lower fabricating costs. And it can result in other important cost reductions, from the initial purchase through handling, shipping and fabrication, to final installation.

EASY TO FABRICATE

Tanks and vessels require high quality welding . . . and aluminum is an exceptionally easy-to-weld material. In fact, welds of comparable strengths can be made five to eight times faster on aluminum than on most other metals! Brazing equally well, it is also one of the most formable, most economical metals to work with.

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Reflecting up to 95% of radiant heat, aluminum provides superior protection for volatile chemicals. And aluminum's high thermal conductivity speeds the transfer of heat.

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Aluminum, due to its excellent mechanical properties and low cost, is the ideal material for handling low temperature liquids such as *liquefied oxygen, nitrogen, methane*, etc.

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Aluminum is finding wider and wider use in the processing industry because no other metal offers so many benefits at such large savings. To learn how Reynolds Aluminum can help you, or for technical service, call your local Reynolds office or write *Reynolds Metals Company, Box 2346-CJ, Richmond 18, Virginia.*

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average of 3% for '60-63 compared with 12% for all manufacturing.

Other pertinent points revealed in McGraw-Hill's survey (detailed analysis will appear in upcoming issue of *Chemical Engineering*):

• In 1960, capital expenditures for all manufacturing will be 1/3 expansion, 2/3 replacement and modernization. But chemicals will reverse that ratio, and petroleum refining will spend only 9% for expansion.

• Depreciation allowances continue to grow: for chemicals, from $1.1 billion in '59 to $1.3 billion in '63; for all manufacturing, from $7.8 billion in '59 to $9.1 billion in '63. In both categories, companies surveyed spend 82% of allowances for new plant and equipment.

Engineer unions getting militant

Engineers' unions (to use traditional union language) are getting militant. Shucking the role of peaceable Chowder and Marching Societies, they are engaging with increasing frequency in vigorous employee-employer battles on a score of issues (*Chementator*, Mar. 7, p. 53). And, note some observers, as was the case with the blue-collar unions of a few generations ago, out of these battles may come new ground rules for engineer-employer relations in the years ahead.

Latest evidence of engineer unions' growing militancy: Current set-to between the Southern California Professional Engineering Assn. and Douglas Aircraft (Los Angeles) over a pay cut proposed by the company last month.

Initially, Douglas announced a 10% across-the-board pay cut for all its 13,500 salaried employees, including the engineers represented by SCPEA. Reason: Need for economies in face of poor business. Company posted a $33-million loss in fiscal 1959. But SCPEA countered that the action violated its contract, filed unfair labor practice petition with National Labor Relations Board almost immediately. Union's view: Pay cut was intended to influence contract negotiations not only with SCPEA (now in progress) but also with the United Auto Workers and the International Assn. of Machinists representing labor groups at Douglas.

Douglas, backing off somewhat, revised its proposal early this month. As now in force, it calls for no pay reduction for salaried personnel earning less than $12,000/yr.; a 5% pay cut for those in $12-$20,000/yr. group; a 10% cut for those in the $20-$50,000/yr. group; a 15-25% cut for those earning over $50,000/yr. Despite the fact that Douglas' action is now aimed only at the highest-paid personnel in the company—and those, presumably, least likely to be "union oriented"—SCPEA has no intention of withdrawing. About 450 engineers are still involved, the union notes, of whom 50% are SCPEA members and all are represented by the union.

SCPEA has completed necessary pre-arbitration procedures. NLRB is now supplying names of five arbitrators from which union and company will select one to review their differences. Arbitration date has not yet been set.

Firms ready Titan's new propellant

Machinery was set into motion earlier this month to provide the 380,000-lb.-thrust Titan missile with its new liquid-propellant system. As disclosed in *CE* (*Chementator*, Mar. 21, p. 75), the Titan will switch from its present kerosene-and-liquid oxygen propellant to a system consisting of hydrazine and unsymmetrical dimethyl hydrazine for fuel, and nitrogen tetroxide for oxidizer.

To provide the hydrazine: Olin Mathieson, currently sole U.S. producer of the material for rocket consumption. Company reports that it has started engineering studies and facilities acquisition for a $15-million hydrazine plant to be built for the Air Force with government funds at Saltville, Va. OM's present hydrazine facility is located at Lake Charles, La.

Most likely to supply the unsymmetrical dimethyl hydrazine: Food Machinery & Chemical and National Distillers & Chemical. Firms have formed a partnership to produce UDMH under name Dimazine at FMC's facility in South Charleston, W. Va. And Air Force reportedly has entered into negotiations with the two companies for purchase of their output.

Hercules Powder undoubtedly has its eye on winning the job of Titan's nitrogen tetroxide supplier. Company discloses that it has underway a four-fold expansion of its nitrogen tetroxide plant at Hercules, Calif. Increased output is expected to be available early this fall. But Allied's Nitrogen Div. should prove to be a key competitor for the Titan assign-

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With the launching of the "Genco 9," General Chemical put its twelfth sulfuric acid barge into service . . . newest addition to the nation's largest fleet operating on coastal and inland waterways.

This unit—with a 1250 ton capacity—is now serving the Pittsburgh area. It adds another important link to General's large and flexible transportation system, which also includes the nation's largest fleets of sulfuric tank cars and tank trucks—all geared to provide reliable, low cost acid delivery service to customers everywhere.

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For specific information on how General can serve your sulfuric acid requirements, write or phone your nearest General Chemical sales office.

*In Canada: The Nichols Chemical Company, Ltd.

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ment. It operates at Hopewell, Va., the U. S.'s only other major nitrogen tetroxide facility.

Rush into polyolefins unabated

Despite the large number of firms already jostling for position, new companies continue rushing into the polyolefin business.

• Confirming industry speculation, Scientific Design announces that it's offering the Swiss Agfo high-pressure polyethylene process under license from Imhico, A. G. Foster Grant is SD's first customer, will build a "multimillion-dollar" plant at an undisclosed site. (Industry observers believe it will be near firm's styrene monomer plant at Baton Rouge, La.) Only other Agfo polyethylene plant is one now being built in Soviet Union under direct Imhico license.

SD's is the first "off-the-shelf" high-pressure polyethylene process to be made available to smaller chemical companies. Foster Grant's plant is believed to be in the 10-15-million-lb./yr. range. As such it fits into the package plant concept under which SD markets its polyvinyl chloride plants. (Polypropylene is also in Foster Grant's plans, but there's no report yet on what process is to be used.)

• Rexall Drug & Chemical and El Paso Natural Gas are teaming up in a joint petrochemical venture to produce high- and low-pressure polyethylene, polypropylene, ethylene and propylene chemicals. Olefin plant will be rated at over 200 million lb./yr.; polyolefin plant will have more than 150-million-lb./yr. capacity. Plants, to be located at Odessa, Tex., will be on stream in early 1962.

Tomorrow's Technology

Today's embryonic developments which have special significance for chemical engineers

Chemonuclear outlook gloomy

Among the more promising applications for the chemonuclear reactor has been nitrogen fixation (*Chementator*, Jan. 11, p. 42). But attempts to commercialize it for the production of nitric acid look none too encouraging at this time.

Aerojet-General Nucleonics recently worked up a preliminary process study for making HNO_3 in a nuclear reactor. Its conclusions: Capital cost for a chemonuclear plant to turn out 107,000 tons/yr. 100% HNO_3 would run about $21.5 million. Production costs, including amortization of investment over a 15-yr. period, would top $43/ton.

By comparison, capital cost of a conventional ammonia-oxidation nitric acid plant of similar size would be about $1.7 million erected. Total production cost would run around $27/ton 100% HNO_3. Of this, about $23 is for ammonia (at about $80/ton)—a figure that could be cut almost in half if the ammonia were produced captively.

System studied by AGN consists of a dust-fueled reactor in which fission fragments from suspended uranium oxide particles combine nitrogen and oxygen to form nitrogen dioxide. Product gas, essentially particle-free, leaves reactor disengaging section and enters separation section where it partially cools and condenses. Liquid N_2O_4 is chief product of separation section. It passes to a processing system where dissolved fission fragments are removed by distillation and nitric acid scrubbing. Gaseous nitrogen dioxide then passes to a converter for reaction with air and water to produce HNO_3.

Variable-thrust solid rocket unveiled

Backers of solid propellant rocket systems have acquired what may prove to be their most potent argument to date. North American Aviation's Rocketdyne Div. (McGregor, Tex.) revealed earlier this month that it has test fired a solid rocket motor whose thrust can be varied between 700 and 1,200 lb.

Until now, this highly desired attribute of thrust variability could be gained only by using liquid propellants (*Chementator*, Jan. 11, p. 42) or hybrid solid-liquid systems (*Chementator*, Feb. 8, p. 58). Best that solid rocketeers have been able to do: Program a specific thrust-variation sequence into rocket by shaping solid propellant configuration so as to obtain a variable burning rate. But this scheme falls far short of a truly "driveable" rocket since it doesn't allow thrust variation to be altered once rocket has been fired.

Rocketdyne hurdled this limitation by designing a rocket motor with a variable nozzle throat area. Thus, velocity of escaping exhaust gases can be increased or decreased and with that, rocket's thrust as well.

For more on DEVELOPMENTS.....42

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• rated for pressures up to 10,000 PSI •

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R-P&C's complete line of bar stock valves includes constructions in 12-14 chromium stainless steel, 18-8 molybdenum stainless steel and bronze. Sizes range from ⅛" to 1" in globe and angle styles with female ends, male and female ends, or male union ends. For extremely severe throttling services, R-P&C bar stocks can be supplied with stellite discs for extra abrasion resistance.

Your R-P&C distributor carries not only a complete line of bar stock valves but also a wide selection of gate, globe, angle and check valves in bronze, iron, and cast and forged steel. You will find the answer to your valve problem in his selection.

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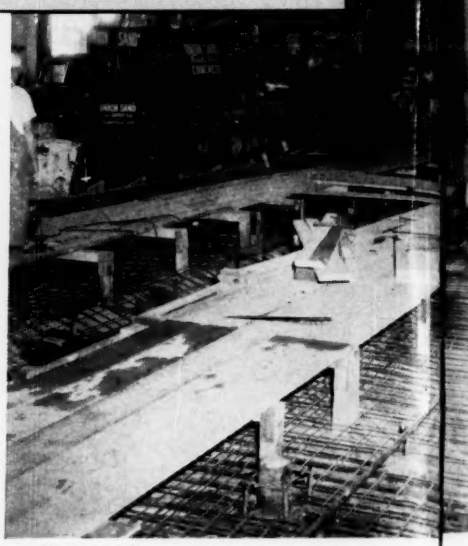


FIRST DAY: Contractor's crew strips away the 30-yr.-old cells and piping. SIXTH DAY: First section goes down

And the Downtime Was Only 14 Days

During fourteen action-packed days off the line, a Diamond Alkali caustic-chlorine plant gets completely new electrolytic cell room.

In terms of a well-worn cliché, Diamond Alkali Co. almost managed recently to have its cake and eat it too. With a sacrifice of only 50% of its production for a short 14-day period, Diamond gained complete transformation of a 30-yr.-old caustic-chlorine cell room to a shining new installation of 30,000-amp. Diamond cells at Painesville, Ohio.

In carrying out this replacement with minimum downtime, Diamond engineers were able to reduce construction time from an estimated 9 mo. to an actual 7 mo. And operation at 50% capacity was cut from the original estimate of 1½ mo. to 14 days from shutdown of the old cell room to startup of the new.

▶ **Plan Continuously** — When queried recently on how his engineers scored this triumph, F. H. Rockwell (see footnote, p. 44) noted that, "The key to success of this replacement program was careful planning through all stages of the job, from early engineering right through actual construction."

While this principle undoubtedly has guided many engineering and construction jobs, Diamond engineers followed it in a way that produced optimum performance.

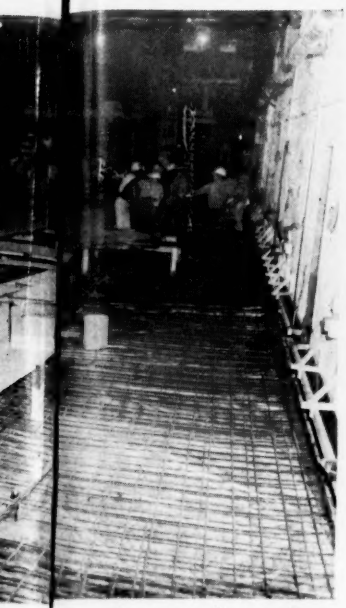
▶ **Who Planned**—At the start, Diamond management set up a specific project organization so that all individuals on the job would know their responsibilities without question.

A staff group from the central engineering department, working closely with operating people, carried out preliminary planning for the job.

Construction and operation proceeded under close guidance of a three-man group consisting of Diamond's project field superintendent, the contractor's general superintendent and Diamond's operations coordinator.

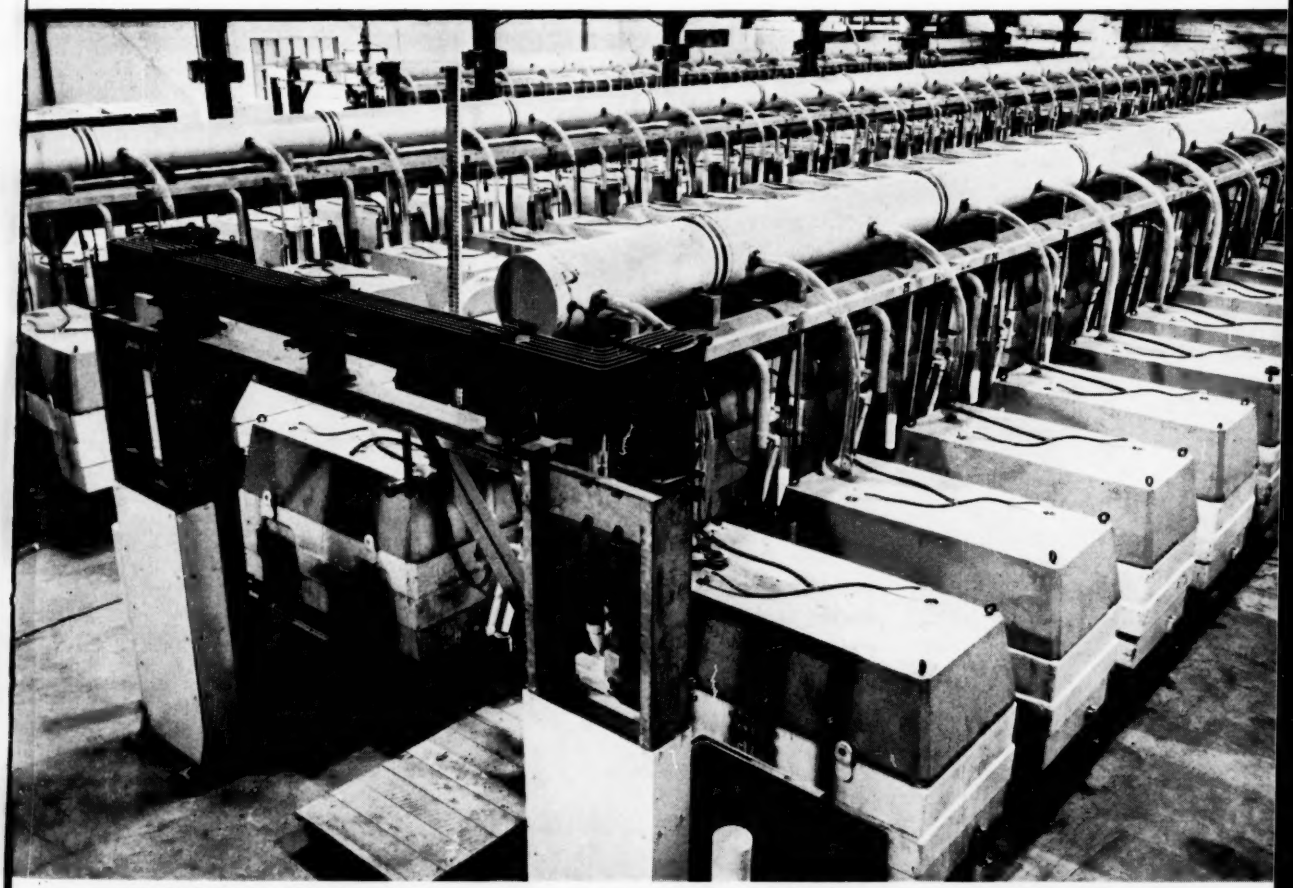
▶ **Three Key Men**—These three men, working together smoothly, contributed significantly to the success of the program. Authority to settle promptly differences arising between construction and operating groups was vested in the operations coordinator, a veteran supervisor of chlorine manufacture.

A measure of success for this three-man team was ability of contractor's men, plant-maintenance forces and plant-opera-



for new cell-room floor

TENTH DAY: While third section of floor is poured, new pipe headers and cells go in.



FOURTEENTH DAY: Completed new cell room goes on the line, reaching rated capacity stepwise within 36 hr.

tions forces to work in very close coordination, one with another.

Contractor's men handled the main construction job while plant-operation forces assembled and installed the electrolytic cells. Plant maintenance forces did tie-ins outside the main construction area.

► **Prefabricate Subassemblies**—How the over-all organization moved toward completion of the project is shown on the accompanying time table.

Prior to the critical 2-wk. round-the-clock changeover, labor forces on the job prefabricated all piping, piping supports and pedestal supports for the cells. Stockpiled outside the cell room, they were ready to move into their assigned locations as soon as needed.

When the project moved into the 2-wk. changeover, half of the old facilities could be kept operating because the 144 new 30,000-amp. cells needed only 40% as much space as the 2,400 old Tucker-Windecker cells. While one old cell room was quickly stripped clean and rebuilt, the other made product.

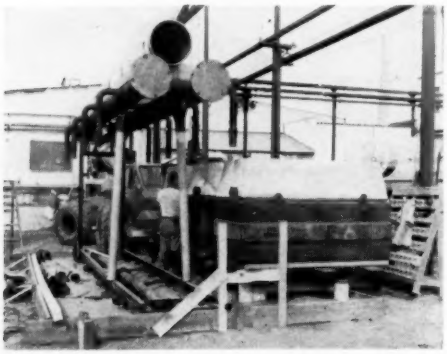
► **Strip and Rebuild** — Once stripped, the cell room received 60 additional steel-encased concrete piles driven to an average depth of 40 ft. in order to support the heavier concentrated load of the new cells.

To raise the floor level, the constructors placed 3,000 yd. of crushed limestone fill over the old floor, then poured 900 yd. of concrete. Concrete was special high-strength mix using high-early-strength cement to shorten curing time.

Heavy cell equipment was moved on dollies pulled by tractors, then hoisted into place with overhead crane installed as part of the new facilities.

Power for the new electrolytic cells is supplied by the same electrical equipment used with the old Tucker-Windecker cells, thereby saving Diamond a major expenditure in this area. Adaptation of this equipment to the new setup required only a modification and centralization of controls so that entire cell room can be operated as one unit.

► **The Payoff**—With the new cell room in operation, Diamond has reduced carbon consumption 48%, reduced other cell renewal and repair material 68%, sliced cell renewal and maintenance labor 58% and shaved electric power consumption 7%.



MOCKUP checks out preassembly procedures used to telescope revamp into two weeks.

Time Table That Produced
Two-Week Revamp of Cell Room

Oct. 1, '58—Engineering begins.

Nov. 25, '58—Diamond management gives final OK.

Feb. 9, '59—Plant forces start clearing site and reinforcing existing structures.

May 25, '59—General contractor moves onto job.

July 10, '59—Move facilities for maintaining old cells to temporary location.

Aug. 1, '59—Build mockup of new final cell assembly.

Aug. 17, '59—Start subassemblies of 30,000-amp. cells.

Sept. 8, '59—4:30 a.m. Take cell room off the line. 6:00 a.m. Complete purging of cells before dismantling.

Sept. 9, '59—6:00 a.m. Completion of removal of all cells, piping and overhead cranes. 8:00 a.m. Start setting up pile-driving equipment.

Sept. 14, '59—Finish driving piles and pouring one fourth of new floor. Start final cell assembly.

Sept. 15, '59—Start erecting piping headers and placing first new cells in room.

Sept. 16, '59—Finish pouring second section of floor.

Sept. 18, '59—Finish pouring third section of floor.

Sept. 19, '59—Completion of all cell-room piping.

Sept. 20, '59—Pour last section of floor. 11:00 p.m. Assemble last cell and set in place in cell room.

Sept. 21, '59—7:00 a.m. Take second old cell room out of service. 2:00 p.m. Complete all piping and electrical tie-ins. 9:45 p.m. Start filling system with brine preparatory to startup.

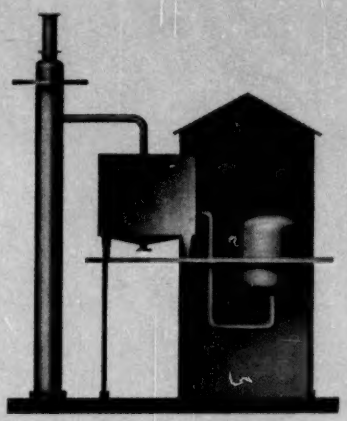
Sept. 22, '59—3:10 a.m. Apply electric power to new cells. With stepwise load increase on cells, they were up to 21,000 amp. within 5 hr. and operating at rated capacity within 36 hr.

Information about Diamond's modernization furnished by F. H. Rockwell, Group Mgr., Central Engineering Dept.; J. T. Ferguson, Gen'l Supt., Electro-Chemical Div., Painesville Works; R. H. Parsons, Mgr. Utilities and Services, Deer Park Works, formerly Technical Ass't to the Gen'l Mgr., Electro-Chemical Div.

The pay-off is in production

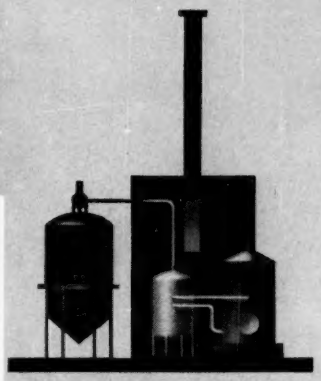
SD announces successful start-ups of 5 more plants

WITCO CHEMICAL COMPANY
Illinois



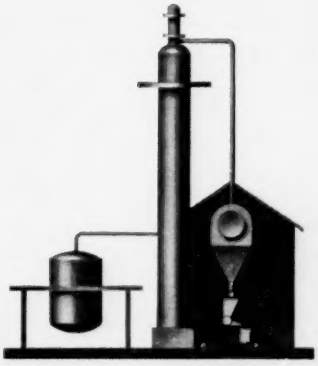
PHTHALIC ANHYDRIDE

CARY CHEMICALS, INC.
New Jersey



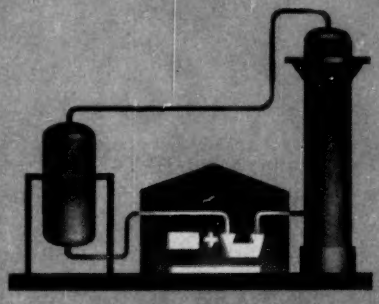
POLYVINYL CHLORIDE

AMERICAN CYANAMID COMPANY
Pennsylvania



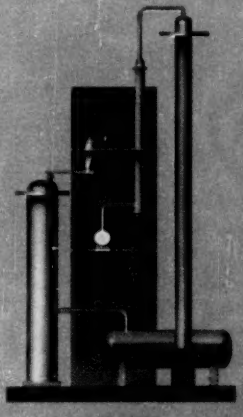
MALEIC ANHYDRIDE

MITSUBISHI PETROCHEMICAL COMPANY, LTD.
Japan



ETHYLENE OXIDE

BRITISH HYDROCARBON CHEMICALS, LTD.
Scotland



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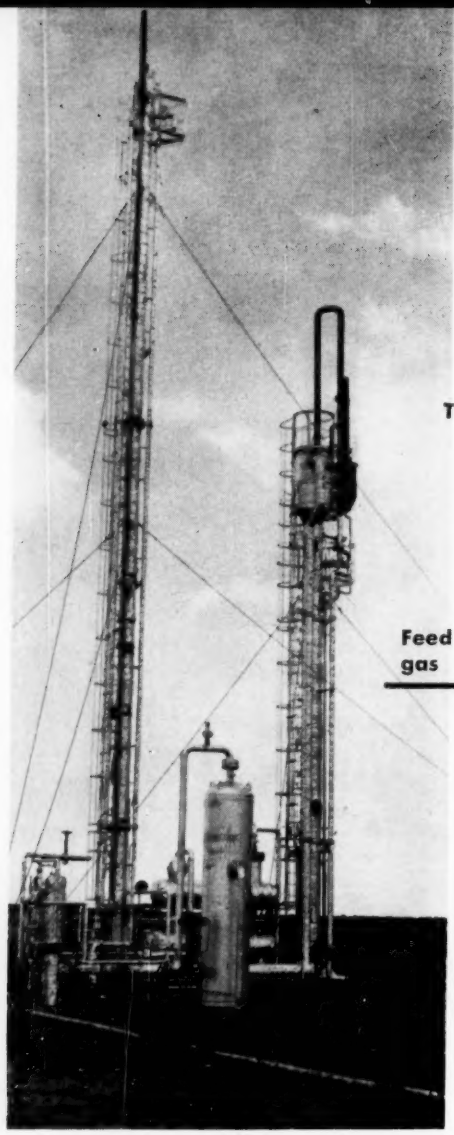
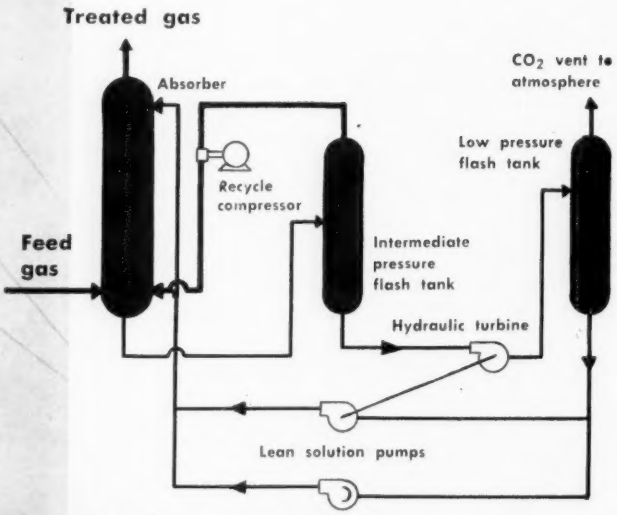




◀ WEST Texas pilot plant proved flowsheet rids gas of CO_2.

Fluor's new flowsheet, centered on new solvent, wins first commercial job at El Paso plant to treat 50%-CO_2-content natural gas.

New Solvent Lowers Gas-Treating Cost

The flowsheet shown above—aimed at treating natural gas of exceptionally high carbon dioxide content and developed by the Fluor Corp., Ltd. (Los Angeles, Calif.)—has won its first commercial job (*Chementator*, May 2, p. 51).

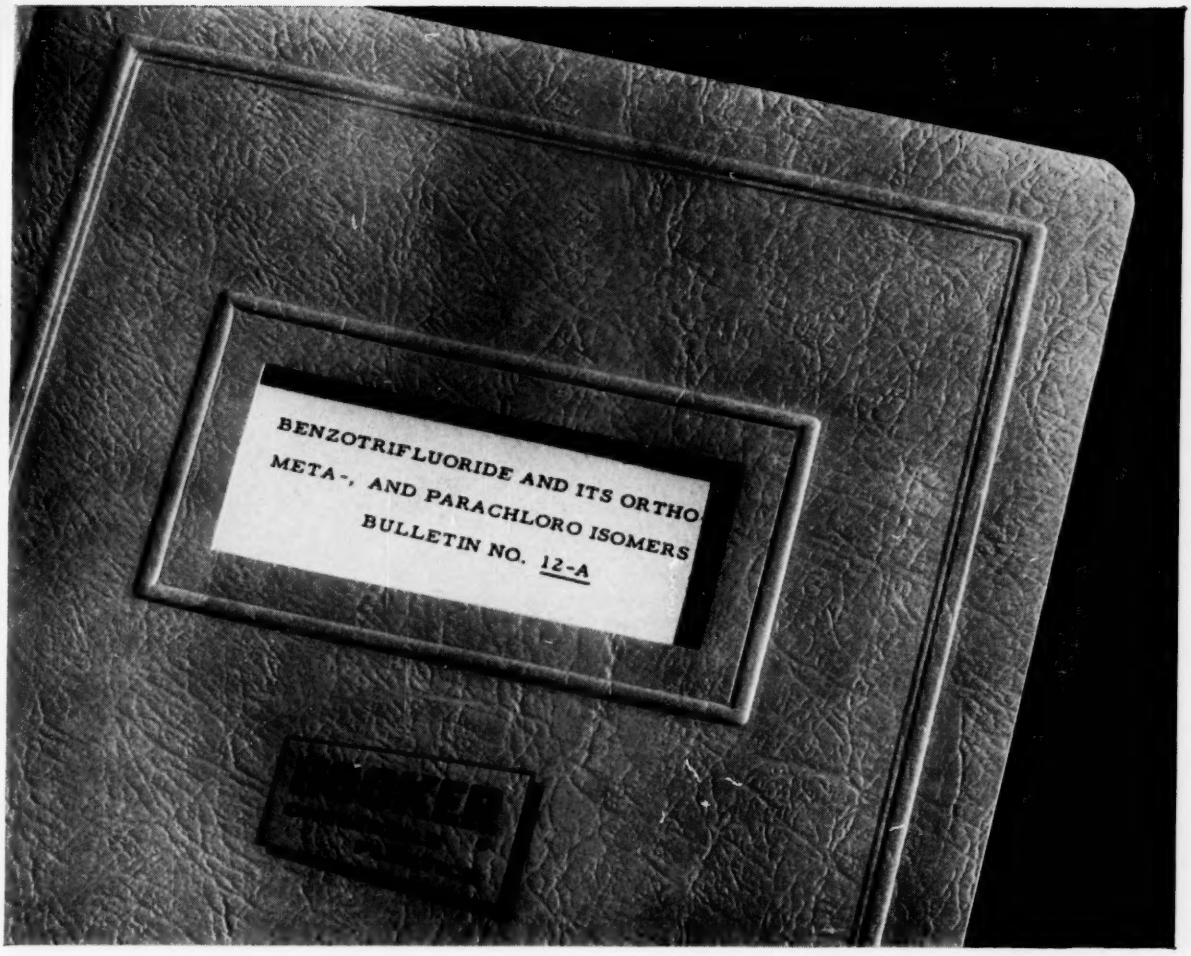
El Paso Natural Gas Co. last month began construction on a $3-million Fluor-process facility at Sheffield, Tex., that will feed on 220 MM cu. ft./day of CO_2-laden natural gas and yield 100 MM cu. ft./day of high-purity product.

To be strikingly simple and compact, installation will be based on a new, patented solvent with a huge appetite for absorbing CO_2, followed by a series of flashing steps to release dissolved materials.

Plant is one element of the $10-million expansion that El Paso has planned for its natural gas operations in the Brown-Bassett fields of Terrel County, Tex., which is to include a gas-gathering system and a 20-in., 51-mi. transmission pipeline as well.

But, undoubtedly, it represents the key element of that expansion. Reason: Plant, thanks to the Fluor flowsheet, is claimed to be able to handle the unusually high CO_2 content—often over 50%—of Brown-Bassett-well natural gas much more economically than competing processes.

Because of this virtue, the



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Here is the latest compilation of facts about Benzotrifluoride and its Ortho-, Meta-, and Parachloro Isomers now produced in commercial quantities by Hooker.

This information (a dozen pages of it) covers physical properties, chemical properties and scores of applications ranging from a lampricide intermediate to pharmaceutical and dye intermediates.

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Please send me a free copy of Bulletin 12-A, *Benzotrifluoride and its Ortho-, Meta-, and Parachloro Isomers.*

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HOOKER CHEMICALS PLASTICS

Fluor flowsheet can lay a persuasive claim for widespread industry attention. For, under the pressure of rapidly expanding use of natural gas as a fuel and chemical raw material, more and more firms are being forced to consider tapping distressingly CO_2-rich gas wells. But, notes a Fluor spokesman, previously available processes could, at best, remove excessive quantities of CO_2 from natural gas streams only at high cost.

▶**Costs Low, Ability High**—To back this contention, Fluor points to comparative economic evaluation it has made on the leading natural gas-treating flowsheets currently in operation. Basis of evaluation: A 110-MM-cu. ft./day plant to reduce gas at 800 psig., 53% CO_2 and 70 F. dew point to 2% CO_2 and 32-F.-dew-point product.

Result, reports Fluor: Using its new process, plant would perform the job for about 2¢/1,000 cu. ft. feed while it would cost roughly 2.7¢ to do it via the Giammarco-Vetrocoke process; about 3.4¢ via a water wash flowsheet; about 4.3¢ via a hot potassium carbonate process. (The well-known monoethanolamine process reportedly is way out of the economic ballpark in this sort of application.)

Moreover, the new Fluor process maintains this economic edge over its rivals even when CO_2 content is as low as 25%, reports the company. Below that, however, the other processes, especially the Giammarco-Vetrocoke route (which, incidentally, Fluor also licenses), begin to gain the upper hand, Fluor concedes.

Too, presence of heavier hydrocarbons in feed (e.g., propane and up), which require special steps to prevent their loss, and need for product of lower than 2% CO_2 content, which also calls for extra processing steps, swing the economics in Giammarco-Vetrocoke's favor.

On the other hand, operation and economics of the new Fluor process are essentially unaffected by presence of hydrogen, nitrogen, hydrogen sulfide and mercaptans in the feed stream.

▶**Solvent Is Key**—Key to the Fluor flowsheet's ability to handle high-CO_2-content natural gas with attractive economics, lies in the choice of solvent used to absorb CO_2.

Though Fluor presently refrains from naming the exact solvent to be used in the El Paso facility, three recently issued patents on the process cite propylene carbonate, glycerol triacetate, butoxy diethylene glycol acetate and methoxy triethylene glycol acetate as first-rank possibilities.

All four materials sport the properties needed to make removal of large amounts of CO_2 from natural gas a genuinely economic affair:

- High solubility capacity for carbon dioxide. This means that solvent circulation rate, thus pumping requirements can be kept at a minimum.
- Low vapor pressure at operating temperature. This eliminates need for refrigeration, solvent vapor recovery and hydrocarbon recovery systems.
- Low hydrogen and hydrocarbon solubility. This beats high loss of valuable hydrocarbons or the expense of plant modifications designed to minimize it.
- Low viscosity, especially at the lower temperatures at which solvent's CO_2 solubility is high and vapor pressure low. This influences size of equipment, particularly the absorber, and mechanical efficiency of pumps.
- Low hygroscopicity. This means little water in solvent stream which, otherwise, would reduce solvent's capacity for CO_2, tend to increase corrosion and solvent decomposition. Too, it means minimum water buildup in feed stream, thus eliminating need for feed-dehydrating equipment that would increase process complexity and plant cost.
- High stability under operating conditions, nonreactive with all components in feed, noncorrosive to common metals and readily available at reasonable cost.

▶**Basic Process and Variations**—In the basic version of the Fluor process, CO_2-rich natural gas at about 800 psig. is fed to the bottom of a conventional absorption column. There it contacts, in countercurrent flow, the solvent which is fed to top of column at slightly sub-ambient temperature.

Solvent absorbs CO_2, water vapor, H_2S, mercaptans and small amounts of hydrocarbons, then leaves bottom of column somewhat warmer than it entered because of heat of absorption. Treated natural gas is taken off top of absorber.

Loaded solvent stream is flashed to an "intermediate" pressure. This results in the release of a major portion of the dissolved hydrocarbons which then are recycled through a compressor to join feed stream to bottom of absorber.

Solvent stream, still at relatively high pressure, passes through a power recovery hydraulic turbine and feeds to an atmospheric-pressure flash vessel. There, the large amounts of CO_2 in stream are desorbed and, in being vented, serve to strip water, H_2S and mercaptans from the solvent. Cooled, lean solvent then recycles to top of absorber.

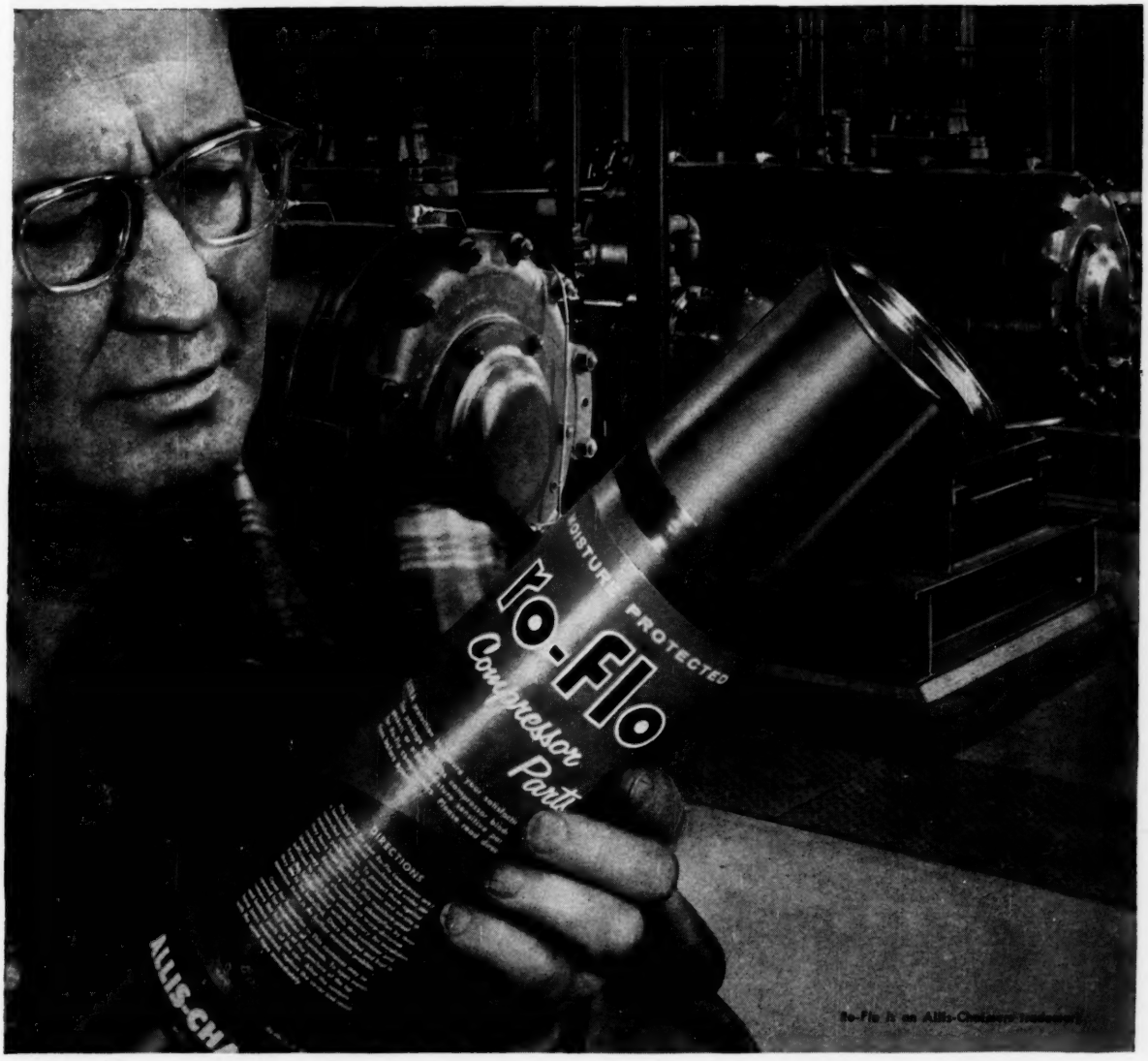
Variations on this process scheme, Fluor notes, can serve to meet specific processing requirements. For example, if a very low CO_2 concentration in the product gas stream is required, air stripping of solvent stream can be added after the low-pressure flash tank. This would be followed by a vacuum flash of the solvent to remove dissolved oxygen introduced in the air-stripping stage.

Too, the efficiency of the hydrocarbon recycle step can be improved by feeding recycle gas into absorber at a point below main gas inlet. This would result in a reduction of the required solvent flow rate at, however, the expense of absorber height.

Or hydrocarbon gas can be contacted with a separate solvent stream before entering absorber. This arrangement would allow a smaller recycle compressor, since most of the CO_2 would be removed before compression. And it also would reduce size of primary absorber by reducing required liquid flow rate and gas velocity at bottom of absorber where rates normally are highest.

Article based on paper by A. L. Kohl and P. A. Buckingham presented at 39th Annual Convention of Natural Gasoline Assn. of America, Houston, Tex.

ALLIS-CHALMERS



Imagine! A package this small

contains the spare parts for your Ro-Flo compressor

A spare parts kit you can hold in your hand — dramatic evidence of the continuous, trouble-free performance that is yours with a *Ro-Flo* compressor.

You need fewer spare parts because there are fewer moving parts to wear out. No pistons, no valves, no connecting rods. Besides the bearings and seals, which all units have, only the rotor blades are exposed to normal wear, and rotary design compensates for it — automatically, by centrifugal force. Average blade life is two to three years, and when finally worn, blades can be replaced in one simple operation.

Smooth rotary motion of the *Ro-Flo* compressor eliminates the vibration and pounding shock of reciprocating units — and the necessity for expensive, heavy foundations. A slab is enough. Smaller units can be mounted directly to the floor.

Two-stage *Ro-Flo* compressors are built in twelve sizes to handle from 250 to 1800 cfm at pressures from 60 to 125 psig. Single-stage units up to 50 psig, from 40 to 3000 cfm. *Ask your A-C representative for descriptive literature, or write* **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wisconsin.* A-1270

Report Recommends Limits For Pollutants

A new element injected into the long-standing pollution controversy between Pacific Northwest oyster growers and local pulp mills promises relief in the hitherto unresolved tussle.

In a report to the Washington Pollution Control Commission, biologist Gordon Gunter and civil-sanitary engineer Jack McKee recommend that sulfite waste-liquor be limited, on an interim basis, to 10 ppm. in the water over Olympia oyster beds from April through October and 80 ppm. over Pacific oyster beds from November through March.

Up to now, WPCC has been working toward reducing the allowable maximum concentration of sulfite liquor to 5 ppm. in oyster growing areas. Director of the WPCC, Art Garton, welcomed the report as indicating, "the commission has been too strict in the past on its water purity decision regarding pulp mills and oysters."

On behalf of the Pacific Coast Oyster Growers Assn., Pres. Edward J. Gruble welcomed the report's recognition that waste sulfite liquor is harmful to oysters and its recommendation of water standards. But he questions use of these standards, except on an interim basis, in view of Gunter-McKee view that concentrations of 8 ppm. or less may be harmful to Olympia oysters and to Pacific larvae.

Before accepting or rejecting proposed standards the WPCC will study the report and hold public hearings.

New Concept in Fuel Cells

General Electric recently revealed details of its new "solid electrolyte" fuel cell along with the disclosure that it is delivering ten portable fuel cell power packs to the Navy for Marine Corps use (*Chem. Eng.*, May 16, 1960, p. 76).

GE's cell converts hydrogen and oxygen directly to electricity, but there the resemblance to other H_2-O_2 cells stops. Heart of the GE cell is an acidic ion exchange membrane which acts as an electrolyte. This frees designers from mechanical problems posed by aqueous and molten salt electrolytes used in other cells, and gives GE a rugged unit which it hopes will prove out in military applications.

Each cell has a membrane 0.030 in. thick covered with a thin Pt-Pd coating which acts as catalyst and electrode. Hydrogen flows to anode chamber where:

$$2\ H_2 \longrightarrow 4\ H^+ + 4\ e^-$$

Liberated electrons flow through an external circuit while the hydrogen ions migrate through the membrane and react with atmospheric oxygen at the cathode:

$$O_2 + 4\ e^- + 4\ H^+ \longrightarrow 2\ H_2O$$

Cell operates at about 0.8 v.; any voltage can be obtained by hooking cells in series. For stacking, cells are kept about 0.1 in. apart by titanium spacers. Power rating for cell is about 20 w./sq. ft. of membrane; thermal efficiency is about 50% at full load.

Production problems seem to limit a single cell to about 2 sq. ft. of membrane area. Ultimately, GE hopes to get the now-expensive membrane down to a lower, even though still expensive, level of $10-15/sq. ft.

Right now GE's portable power pack gets hydrogen from a replaceable 9-lb. fuel cannister containing sulfuric acid and sodium borohydride. But high cost of the hydride (about $30-40 per charge) is prompting consideration of bottled hydrogen. Until now, pressure containers to hold hydrogen at sufficient pressure were too heavy for use in the portable unit. But rapid developments in filament-wound plastic bottles promise a container that will hold enough H_2 for 14 hr. of operation with little increase in weight over present fuel canister.

Materials in Battle For Pipeline Uses

In a flood of claim and counterclaim, three materials—steel, aluminum and polyethylene—are jockeying for position in the huge natural gas pipeline market. Spurring on newcomers aluminum and polyethylene is the more than four million tons of steel which is bought each year for gas gathering, transmission and distribution.

Alcoa, for example, recently completed installation of a mile-long aluminum gas-gathering line using its new 6-in. Unistrength pipe (heaviest at the ends where it is welded). Line connects a Louisiana gas well to the collecting system of Columbia Gas System.

Aluminum bases its case mainly on its corrosion resistance which allows it to be laid in a trench without coating or wrapping. And use of variable-thickness pipe allows a 20% cost reduction over previous Al pipeline installations (*Chem. Eng., November* 2, 1959, p. 122).

▶ **Enter Polyethylene** — Phillips Petroleum, however, is enthusiastic about using high-density polyethylene pipe for gas gathering. Phillips is using the plastic pipe "wherever applicable" in its gas fields in sizes 2 in. through 8 in. Phillips has developed a butt fusion technique which makes pipe welding so simple that two men can lay more than a mile of 6 in. pipe per day —without elaborate training.

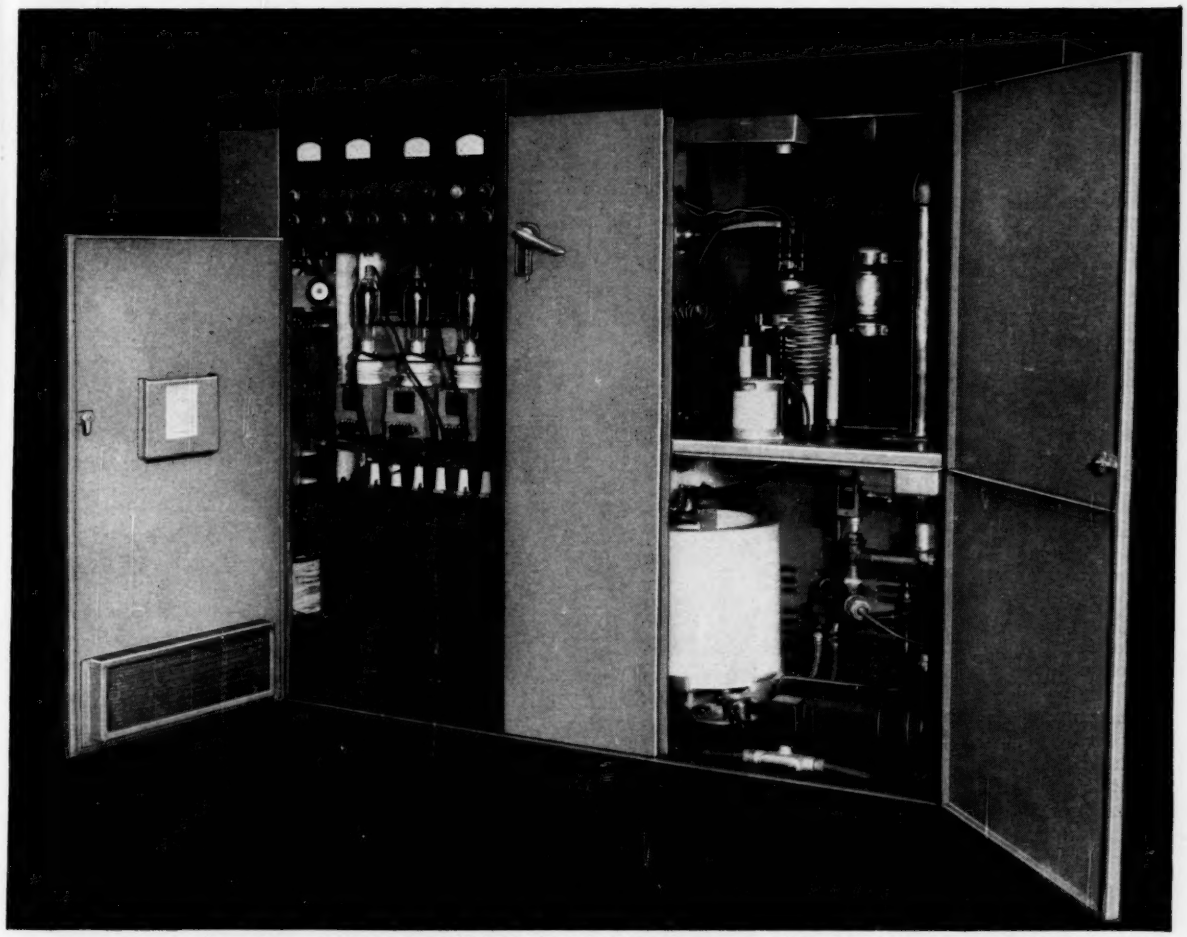
As for costs, Phillips calculates that a 3-in. schedule 40 polyethylene pipeline can be installed for 84¢/ft. By contrast, a pipeline of schedule 40 steel pipe will cost $1.11/ft.

▶ **Steel Fights Back**—To combat inroads made by newcomers into traditional steel markets, steel producers are constantly improving their products.

National Steel Corp. has just introduced a new class of high-strength, weldable steels (called GLX-W steels). Incorporating columbium, these new steels are claimed to give pipeline engineers a unique combination of strength and weldability at "competitive cost."

Five miles of 24-in. pipe of the new steel (45,000-psi. grade) has

ALLIS-CHALMERS



Large doors permit easy accessibility. Wiring arrangements make inspection and maintenance easy and straightforward.

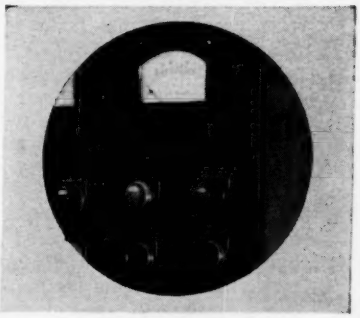
Allis-Chalmers dielectric heaters

cut heat-processing time to minutes

To help you cut time and costs on jobs calling for heating, drying, baking or curing of nonconducting materials, Allis-Chalmers provides complete dielectric heating systems. Every detail is designed to help assure full-capacity operation with minimum maintenance and supervision. *Loadmaster* control, for example, regulates the flow of materials automatically to give you maximum utilization of power and equipment. Eye-level, "grouped" controls facilitate a quick appraisal of operating conditions. Protective interlocks assure complete safety. Oscillators and rectifiers are built to last 5000 hours or more, and heavy-duty plate transformers provide large reserve capacity. Most important, Allis-Chalmers extensive engineering and research facilities assure you of proper application and installation.

Typical dielectric heater applications include: twist-setting rayon cord, jelling rubber, heating inert powders, preheating molding powders, and drying rayon.

Call your nearby A-C man for details, or write to ***Allis-Chalmers,*** *Industrial Equipment Division, Milwaukee 1, Wisconsin.* A-1277



Eye-level controls give easy readability, accurate information on operating conditions. Controls are "grouped" together to give you a complete "picture" at a glance.

already been incorporated in a Texas gas pipeline. Reportedly, the improved properties of the new steel cut field welding costs by $224-316 per mile of line, a 10-15% reduction.

Solvents Stripped from Plastic Resins a New Way

Standard Steel Corp., Los Angeles, Calif., has come up with a new process for removing hydrocarbon solvents from plastic resins. Key to the new technique is the use of superheated solvent vapor as a heat transfer medium to remove liquid solvent from resin particles.

Advantages claimed for the new process are a lower capital investment than dryers now in use and more efficient operation because of minimum amount of inert gas in the system. Since there are no metal heat transfer surfaces in contact with the resin, there is no danger of resin building up on dryer walls and decomposing. Too, heat utilization is claimed to be better than in conventional systems, giving shorter drying time.

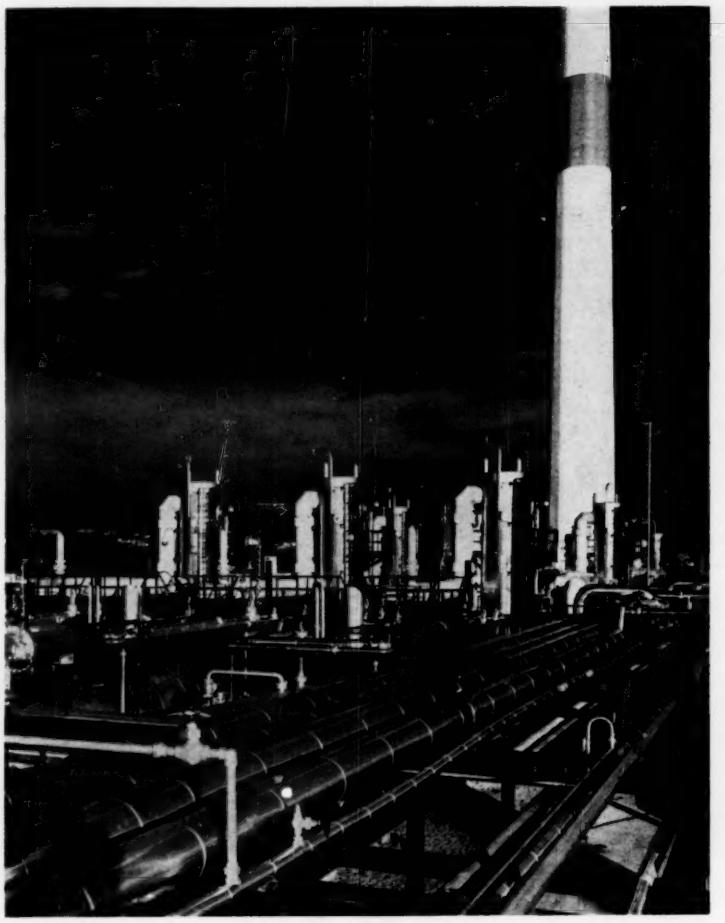
▶ **How It Operates**—Solvent-impregnated resin particles feed to a sealed rotary drum dryer. Superheated solvent vapors enter the drum (either in countercurrent or cocurrent flow) and the heat content of this gas vaporizes solvent in the resin.

Solvent vapors leaving the dryer flow to a primary cyclone which removes entrained fines. Vapors then pass through a cloth filter or wet solvent scrubber where some of the solvent condenses out and is returned to the resin production process.

Remaining solvent vapor passes through a steam-jacketed heat exchanger where it is reheated and recycled to the dryer. Specially designed seals on the system block all solvent losses, says Standard Steel.

Process has already been used to remove solvents such as hexane, methyl alcohol and methyl acetate from resins such as polyethylene, polypropylene and polyvinyl alcohol. Several commercial units are now being installed.

INDUSTRY NEWS



NATURAL gas plant at Lacq, France, adds new unit to recover sulfur.

SNPA (Societe Nationale des Petroles d'Aquitaine) has placed a 1,000-ton/day sulfur recovery unit on stream at its natural gas processing plant at Lacq, France. Unit will be joined in a few months by a twin, bringing total processing capacity to 750 million cu. ft./day of raw gas, and total sulfur recovery to 4,000 long tons/day. The new Lacq units are reportedly the largest sulfur recovery plants in the world.

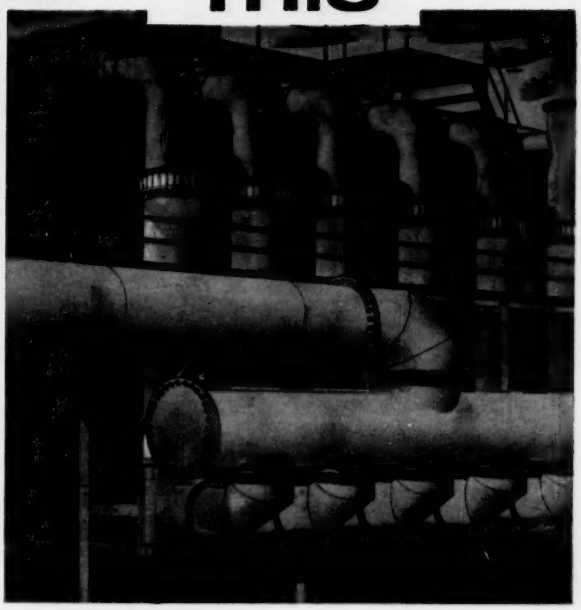
Commonwealth Edison Co. has begun supplying electric power to northern Illinois consumers from its Dresden Nuclear Power Station near Morris, Ill. Initial output of the full-scale, privately owned plant reached 16,000 kw. Rate is being stepped up gradually, with operation at full capacity of 180,000 kw. expected this summer. Plant was built by GE; total cost was over $51 million.

Firestone Tire & Rubber Co. is currently conducting a $120-million worldwide construction and modernization program. Included are five new

Industry News continues on page 128

THE DIFFERENCE BETWEEN

THIS and THIS



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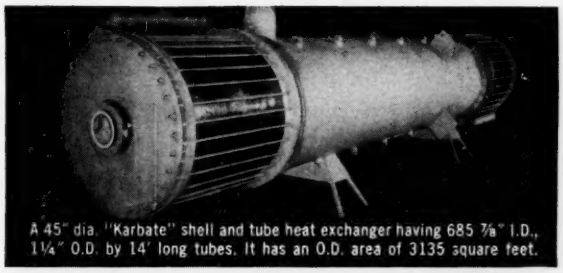
"KARBATE" IMPERVIOUS GRAPHITE HEAT EXCHANGERS!

Today, it doesn't make sense to sacrifice space, money, and minimum downtime by using heat exchangers not having the features of *unsurpassed corrosion-resistance, compactness, and low maintenance of "Karbate" impervious graphite exchangers.* Space was saved, piping simplified, and low maintenance was achieved when the "jungle" of single tube down-draft lead coolers (above left) was replaced by 6 compact "Karbate" shell and tube units (above right).

"Karbate" impervious graphite's high thermal conductivity and complete corrosion-resistance permit these heat exchangers to operate at higher velocities with associated increased heat transfer. This means that "Karbate" units with less surface area can thermally and economically replace larger metal exchangers in which high velocities produce localized accelerated corrosion. In such a case, "Karbate" exchangers with 83% less surface than carbon steel exchangers perform the same cooling job. And, at a total installed cost of approximately $10,000 less than the cost of retubing the corroded carbon steel exchangers with stainless steel tubes.

Actually, "Karbate" units offer unexcelled corrosion resistance at prices, in some instances, up to ⅓ less than many alloy and special metal units in which corrosion is measurable.

If you are considering a new heat exchanger installation, or if you have to replace or add to your present equipment, investigate the advantages of price, excellent corrosion-resistance, and trouble-free performance provided by "Karbate" impervious graphite shell and tube exchangers. For information, write National Carbon Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. In Canada: Union Carbide Canada Limited, Toronto.



A 45" dia. "Karbate" shell and tube heat exchanger having 685 ⅞" I.D., 1¼" O.D. by 14' long tubes. It has an O.D. area of 3135 square feet.

"National", "Karbate" and "Union Carbide" are registered trade-marks for products of

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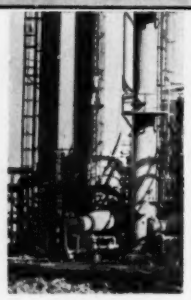
DEVELOPMENTS . . .

CHEMICAL ECONOMICS

EDITED BY FRANCES ARNE



Lineup for the Series:

1. Petrochemical Industry Maps Its Mature Years
2. Methane Chemicals
3. Ethylene Chemicals
4. Propylene Chemicals
5. Aromatics

Petrochemicals-1

An Industry Maps Its Mature Years

Grown 200% in a decade, petrochemicals are now of age. Marketing now dominates industry problems; raw material source and end user team-ups are common. Profitability is a more delicate matter than ever.

Richard F. Messing and James W. Bradley, Arthur D. Little, Inc.

Now widely recognized as one of the major contributors to chemical-industry growth, petrochemicals continue to attract interest of both oil and chemical companies concerned with exploiting their potential. However, latest statistics clearly show that the petrochemicals industry has crossed the threshold into maturity, and the complications of maturity have already set in.

▶ **New Products**—The industry has always been characterized by frequent introduction of new products.

• What appears to be a slow down in the introduction of new large-volume petrochemicals may be evidence that the industry is maturing and that annual growth rate in the future will be below the 13-14% of the past ten years.

• Now many of the new large-volume products are not creating new markets as much as they are competing with existing petrochemicals or derivatives. Conversely, the greatest impetus to the industry's 200% expansion during the past decade was the commercialization of new petrochemicals and derivatives whose markets were not created by infringing on other synthetically derived petrochemicals.

• Antidote, that could keep growth rate up, might be acceleration in the development and introduction of new products.

▶ **New Producers**—Another industry constant has been frequent entry of new producers. Nature of the industry, which dictates high investment per pound of product, large minimum economic size units, high break-even points, has restricted participants to companies that can secure strong financial resources. Advent of industry maturity is further refining qualifications for participation.

• Inherently large minimum economic plant sizes required have contributed to the surges of new construction and overcapacity that continue to plague the industry. Moreover, the

Petrochemicals Flow Chart

Flow chart of major petrochemicals, reproduced on the following page, shows the relationship between major products, markets, starting materials and processes which are involved. Of particular interest is the close interrelationship between the products of this industry and several alternate paths available to reach a given family of end products. Each time a product recurs, a new set of conditions for economic choice is defined.

RICHARD F. MESSING is manager and JAMES W. BRADLEY is a member of Arthur D. Little's industrial economic group. Both have been active working on technical-economic studies for the process industries. Messing joined the company in 1945. He received undergraduate training in chemical engineering at the University of Minnesota, did graduate work at Illinois Institute of Technology. Bradley earned his A.B. at Lafayette and an M.B.A. at Cornell.

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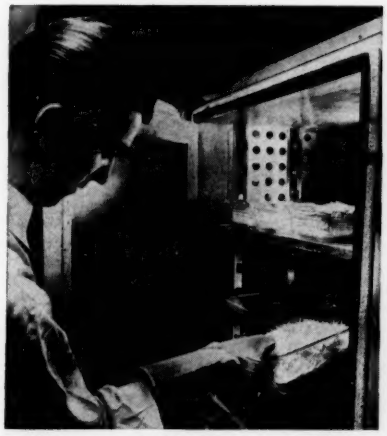
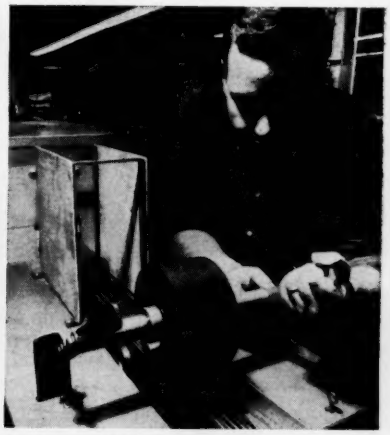


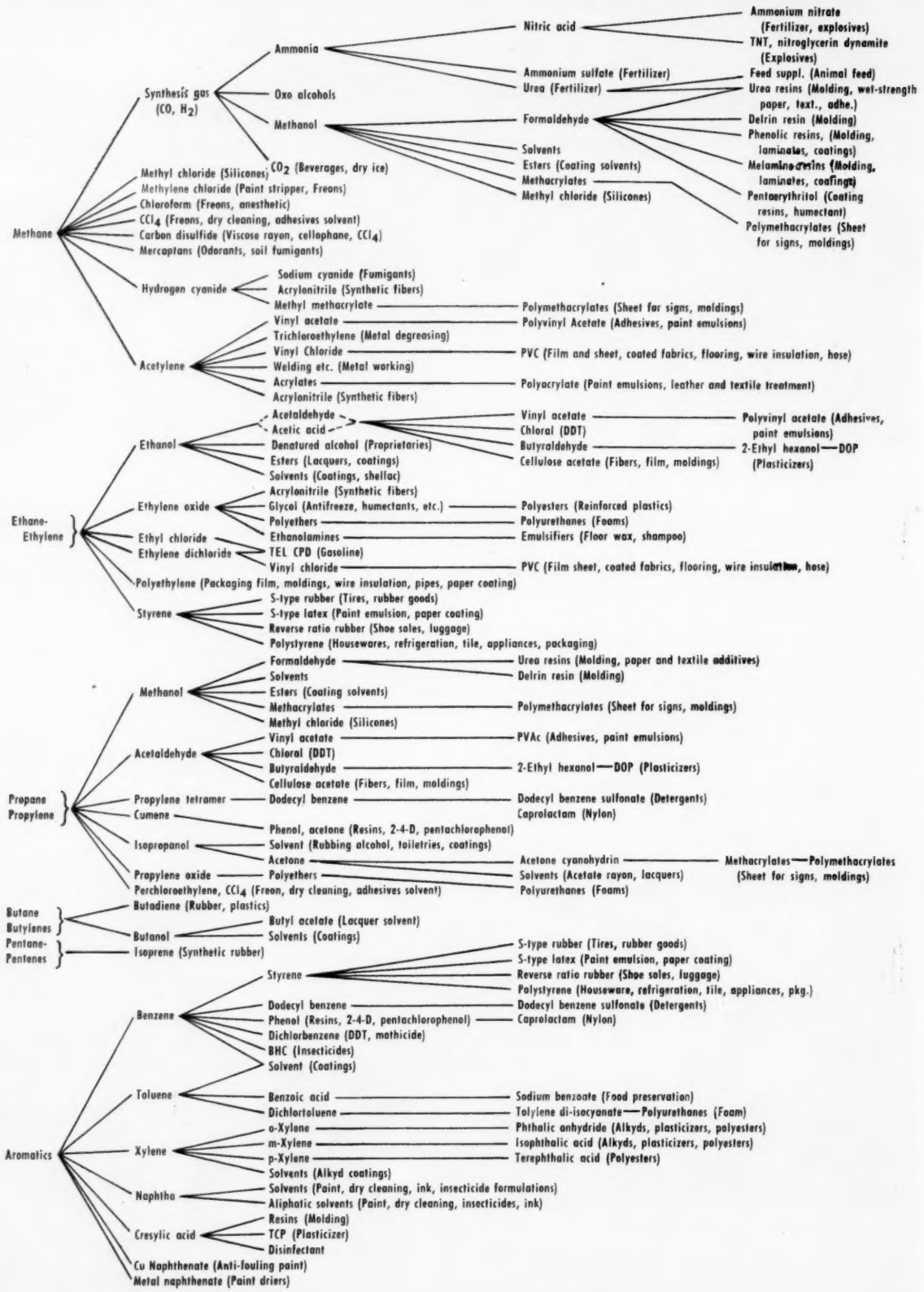
Insulators are stored in paraffin-sealed boxes, then baked to remove last trace of moisture. Assemblers wear gloves to prevent contamination of thermocouples.

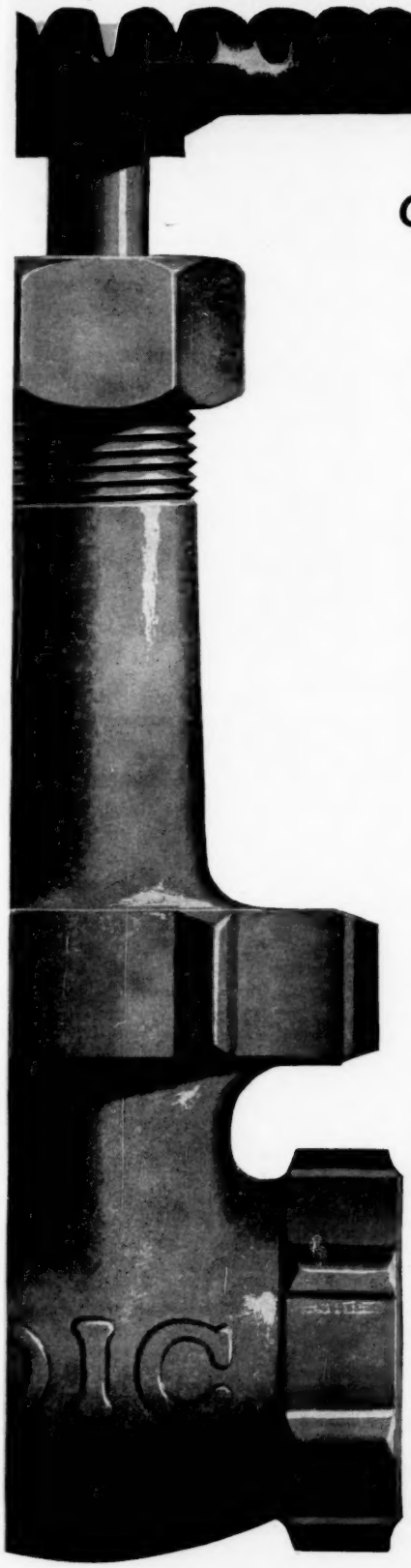
Single-pass swaging of carefully-sized wire-insulator-sheath assembly produces no distortion in wire, insures greater accuracy and longer life.



Continuous hydrogen-annealing not only produces a ductile, brightly finished product, but also identifies improperly compacted material which is rejected during inspection.

Industry Outline Shows How Products Recur, Identifying Economic Choices





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minimum plant sizes of new units for established products are rising to meet competition from older, partially depreciated plants.

• Higher plant investments which cannot be recovered through higher prices in an increasingly competitive market have forced new producers to construct larger plants to attain profitable operation.

• In today's economy, marketing is more difficult than securing process knowledge, raw materials, or plant construction. The contrary was true ten years ago for many petrochemicals, including polyethylene and ammonia, both currently in excess supply. Joint ventures, therefore, are common today, when one partner has internal demand for the products and/or an advantageous marketing position.

▶ **Profitability**—The industry is further characterized by low profitability per dollar of investment on basic petrochemicals, higher profits on upgraded petrochemicals and derivatives.

• Dollar value, however, has gone up as rapidly or slightly faster than physical output, due in large part to the introduction of new high-priced petrochemicals and derivatives, in spite of the trend toward lower prices on many existing products.

• With petrochemical demand outstripping the slow rise in demand for refined petroleum products and the current greater profitability from petrochemical production, the oil industry in the past two to three years has been taking a new look at petrochemicals and, in fact has accounted for a large part of the recent construction activity.

• Hydrocarbons from natural gas and petroleum are becoming expensive as fuel and chemical demands increase, as evidenced by rising natural-gas prices. Chemical companies, such as Dow, Monsanto, W. R. Grace, have been impelled to secure their own hydrocarbon sources. Equally important has been the existing production of petrochemicals by the company being acquired, giving a base for further upgrading and expansion.

▶ **Proof of Age**—In the ten-year period through 1959, petrochemicals grew from about 16 billion to 49 billion lb. Dollar growth was just as great, from about $2 billion to over $6 billion. During this same period petrochemical growth in pounds exceeded total chemical-industry growth by 50%.

On the basis of physical volume, petrochemicals now account for about 28% of all chemicals produced; in terms of dollars, petrochemicals are now the single largest segment, accounting for about 55% of the value of all chemicals produced. Nevertheless, petrochemical raw-material requirements remain a minor fraction of petroleum and natural-gas consumption; in 1959, for example, the year of highest output to date, petrochemical consumption of natural gas and petroleum accounted for less than 4% of total U. S. hydrocarbon production.

▶ **Foreign Markets** — In most cases foreign demand has been rising faster than in the U. S. In 1959, for example, about 300 million lb. out of a total of 1.1 billion lb. of polyethylene produced in this country were exported. Foreign nations are rapidly increasing their petrochemical capabilities, and U. S. exports as a proportion of total foreign consumption are now decreasing.

The establishment of the two European trading blocks has also encouraged local production by U. S. firms, often in conjunction with foreign chemical producers. The purpose has been to maintain a market position which probably would be lost to shipments from the U. S.

With raw materials for petrochemical manufacture available in most parts of the world and with petrochemical demand increasing, plus the fact that trading blocks now allow minimum economic-sized units abroad, the trend to local production should accelerate.

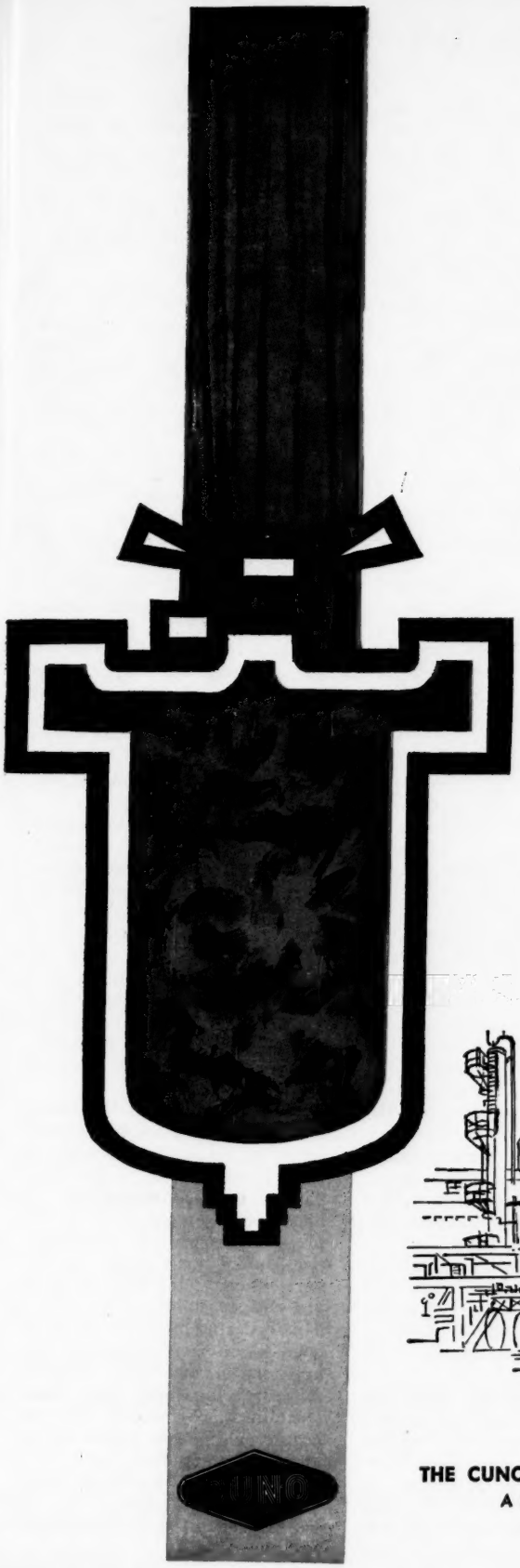
▶ **Marketing Dominates** — In some segments of the chemical industry, such as the synthetic-fiber and pharmaceutical areas, individual companies have protected positions because of special process know-how, patents, or other restrictions. New producers, however, can and have entered most areas of the petrochemical field, increasing competition and placing a ceiling on profitability. Processing methods are standardized, and turn-key plants are available for many basic petrochemicals. Variations between plants undoubtedly give some producers a cost advantage, but in general there is no major difference in the economics of manufacturing between plants of comparable size and age.

As a result, the marketing factor has become increasingly important as competition has intensified. Joint ventures aimed at market position are common, for example: Sun Oil and Olin Mathieson for Sun-Olin Chemical to make urea from Sun's raw materials; Stauffer and Richfield Oil form American Chemical on the West Coast; Sun Oil and American Viscose form AviSun in the East; the proposed Sinclair Oil-Koppers styrene venture on the Gulf.

▶ **Oil Companies Attracted** — Many petroleum companies were reluctant to enter petrochemical production when there were demands for new refinery capacity. The concept that petrochemicals were small in volume relative to petroleum products and petrochemicals were "foreign" to refining also were factors. Now that demand for new refinery capacity has waned, the oil industry has accounted for a large part of the most recent construction and planning activity. Examples: Humble Oil—polypropylene, Gulf Oil—theylene and oxoalcohols; Sinclair—high-purity propylene and styrene (with Koppers); Continental Oil—long-chain alcohols; Amoco Chemical—dibasic acids; Sohio Chemical—acrylonitrile; Phillips Petroleum — polyethylene, polybutadiene and other products.

▶ **Bigness** — Petrochemical plants are now rarely constructed for less than $5 million. Expenditures are frequently above $10 million, and single units costing more than $50 million are not uncommon. The break-even point for petrochemical operations is unusually high, often above 70%.

Donwtrend in some prices is forcing new producers to construct increasingly larger plants to attain a profitable operation. An example of a substantial downtrend is in polyethylene.



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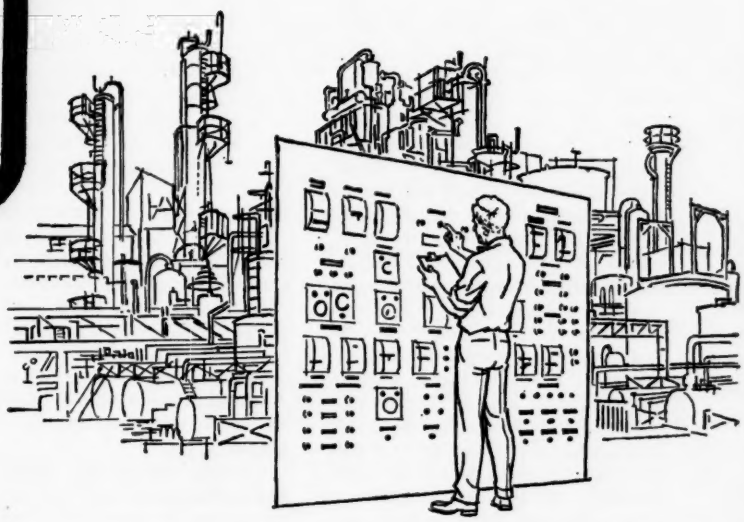
Whenever *you* have a filtration problem, write us. Our engineers will welcome the opportunity to demonstrate how you can *depend on* CUNO.



THE CUNO ENGINEERING CORP., DEPT. 14, MERIDEN, CONN.

A Leader in Industrial Filtration for More Than 30 Years

In Canada: Peacock Bros., Ltd., P. O. Box 1040, Montreal 3, P.Q.

which was 45¢/lb. in 1950 and is 32¢ today. The Nelson Refinery cost index, one of several general measures of petrochemical plant costs, rose 54% from 1950 to September 1959. Fifty million pounds was considered the minimum plant size for ethylene in 1950; now it is 200 million lb. or more. Ammonia has gone from 100-125 to 150-200 tons/day.

▶ **Utilities Interested, Too**—The relatively low profitability for new basic petrochemical units (such as the olefins) is perhaps less restrictive for the petroleum companies, since production of basic petrochemicals is often viewed as only a first step in a program to enter the industry. Consumers of ethylene, partly for this reason, have tended recently to prefer to purchase rather than manufacture ethylene. In addition, some utilities, such as Columbia Gas, are seriously eyeing petrochemicals, not only as a diversification move, but also as a means of bringing in higher profits than are allowed from the regulated phase of the utility business.

▶ **Research Intensifies** — The consistently heavy research and development efforts, one of the major characteristics of the industry, have resulted in the constant addition of new products and processes — polyethylene, ethylene glycol, synthetic glycerin, etc.; this has been the most important factor in petrochemical growth. However, the production of new products, or old ones, based on new processes, has not been without failures. Some projects, though attractive from market and economic standpoints, and apparently feasible based on experience with small-scale plants, have not worked out in full-scale operation. Examples of this process limitation include ventures for the production of synthetic gasoline and chemicals from natural gas; synthetic ammonia via oil oxidation, phthalic acids, and isosebacic acid. However, most recent plants for new products or products based on new processes have worked out well technically.

If petrochemical growth is to approach the 13-14%/yr. rate of the past, the development and introduction of new products must be accelerated. Many of the new large-volume products are not creating new markets as much as they are competing with existing petrochemicals or derivatives. Polypropylene will find most of its uses, not in completely new markets, but in competition with polyethylene and polystyrene. Polyisoprene, on the other hand, will compete at least initially with natural rubber and not with petrochemically derived synthetics.

ZnO Use Realigns In Rubber, Paint Markets

Analysis of the substantial shift in the proportionate use of zinc oxide by the rubber and paint industries over the past decade was recently made by R. H. Crossley, St. Joseph Lead Co., before the American Zinc Institute. During the '50's, the two industries have consumed about 80% of the total zinc oxide.

Consumption by the rubber industry has shown a fairly steady increase, and the curve seems to predict about 100,000 tons/yr. by 1965, or about 50% of the total, as compared with 88,000 tons, or 38% of the total, in 1950. In contrast, consumption by the paint industry has shown a steady decline from 104,000 tons, or 45% of the total in 1950, to about 60,000 tons, or 31% of the total in 1959. Estimates for 1965 are about 65,000 tons based on a slight upturn noted in 1958 and 1959.

All other uses remain fairly constant at about 40,000 tons/yr. and no great change in this category is expected, since no important new uses have been developed. It is apparent that the principal reason zinc oxide has not kept pace with industrial production as a whole has been its decline in use by the paint industry.

Growth curve for paint has been consistent and paint consumption of about 670 million gal. by 1965 is not unlikely. However, increasing gallonage of paint has been made with little or no zinc oxide. Much of this decline can be attributed to reformulation techniques: (1) Replacement of leaded zinc oxide with lead-free, which reduces total used, since only about three-fourths as much lead-free is needed to maintain the same zinc content; (2) Replacement of linseed oil vehicles with synthetic resin types, with reduction or elimination of zinc oxide; (3) The increasing use of emulsion paints containing no zinc oxide (from only a few gallons in 1950, estimates are that they will represent nearly 14% of the market in 1965, or about 94 million gal.).

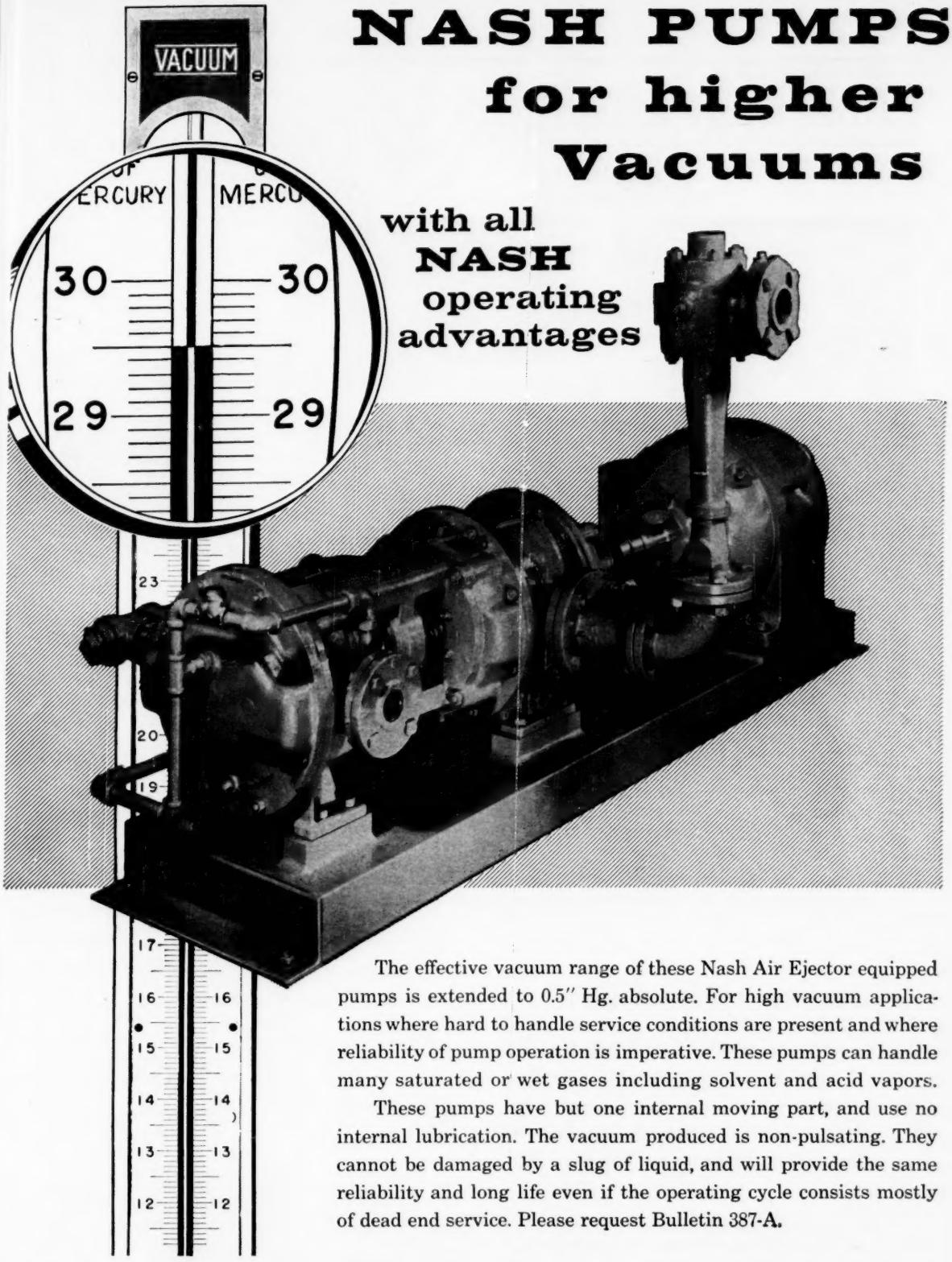
During the past decade, population has increased about 20% and over-all industrial production by 28%. Consumption of rubber and paint have generally kept pace, but consumption of zinc oxide has not. Use in rubber is not increasing as fast as rubber-consumption is increasing. Use in paint is decreasing and no significant new use has been discovered to compensate for this decrease.

The most important single reason for the decline in use of zinc oxide by the rubber and paint industries has been its cost. Products of these industries are not sold on a weight basis, but on a volume basis—therefore the volume cost of ingredients is important. Zinc oxide at 14½¢/lb. and having a specific gravity of 5.60 is the most expensive ingredient in a rubber or paint formula on a volume basis. It is obviously the prime target of the technician trying to reduce raw material costs.

In order to combat this trend, the zinc industry has consistently improved its product in order to give customers more for their money. Surface-treated zinc oxides have been produced to improve dispersion in rubber, and zinc oxides with improved dispersion characteristics in paint are now available. Pelletized or densified zinc oxides were developed which save customers storage space and also improve material handling and plant cleanliness. Unitized or palletized shipments were introduced, which reduced customers' unloading and handling costs, and bulk shipments are now being field-tested which promise further savings.

NASH PUMPS for higher Vacuums

with all **NASH** operating advantages



The effective vacuum range of these Nash Air Ejector equipped pumps is extended to 0.5″ Hg. absolute. For high vacuum applications where hard to handle service conditions are present and where reliability of pump operation is imperative. These pumps can handle many saturated or wet gases including solvent and acid vapors.

These pumps have but one internal moving part, and use no internal lubrication. The vacuum produced is non-pulsating. They cannot be damaged by a slug of liquid, and will provide the same reliability and long life even if the operating cycle consists mostly of dead end service. Please request Bulletin 387-A.

NASH ENGINEERING COMPANY

SOUTH NORWALK, CONNECTICUT, U. S. A.

TRANSPARENT sheets of Kordite 1500 stay clear in 6 to 8 thicknesses.

Polypropylene Film:
Points Toward Packaging Market

Heat-sealing, biaxially oriented film rivals cellophane in moisture protection, shelf life, cost.

"May eventually become one of the most useful and low-cost packaging materials ever made," is the high hope envisioned by National Distillers' board chairman for a new, heat-sealing, oriented polypropylene film produced by ND's Kordite Co. division.

The new material, Kordite 1500, is said to combine best properties of cellophane and polypropylene film while minimizing drawbacks of each.

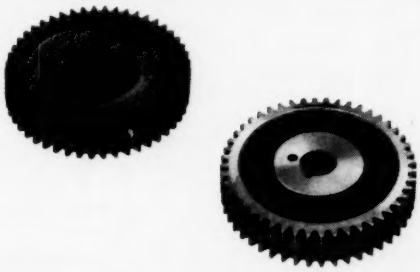
Major advantages of the new film which should help it compete for the one-billion-pound flexible packaging material market are:

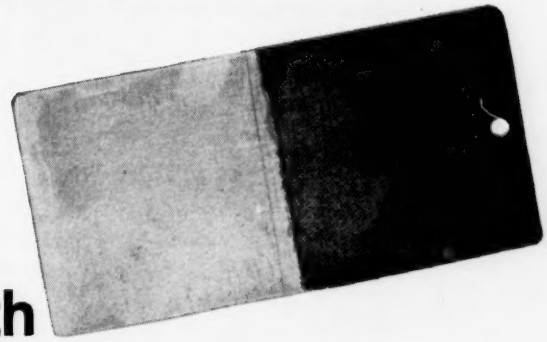
- **Economy**—Eventual cost is expected to be 50% of cellophane cost.
- **Transparency and Sparkle**—Equal to cellophane.
- **Machinability**—First thermoplastic polyolefin film which can be used with most overwrapping machines without major machine modification.
- **Strength**—Film possesses strength and stiffness far better than those of any low-cost, heat-sealing polymer film now on market. Tensile strength equals that of aluminum (20,000 to 40,000 lb./sq. in.). Modulus of elasticity is 7-10 times that of polyethylene.
- **Moisture Permeability**—Properties of moisture-resistance are twice those of cellophane.
- **Peelable Heat Seal**—Like cellophane, but unlike plastic film, produces heat seal over wide temperature range.
- **Grease Resistance**—Provides barrier against vegetable and cooking oils as well as petroleum-base greases.

Kordite admits that the new product has one significant shortcoming: under very high humidities there is a slight tendency for layers of film in the roll to stick together. The company hopes to correct this soon; at present, the deficiency is overcome by storing rolls in conventional polyethylene bags.

Kordite has a density two-thirds that of cellophane, and therefore will go much further pound for pound. Low coverage cost is possible because the material need be only one half as thick as cellophane to give equal protective properties. Film is

Whatever form of metal you handle...





prevent corrosion with SOLVAY SODIUM NITRITE

Your iron and steel parts in process—of every size, shape and type—will resist corrosion if you treat them with Solvay® Sodium Nitrite. Dissolved in water in economical, low concentration, it coats the corrosion-free parts pictured above—striking contrast to the untreated, corroded mates.

This easy-to-apply protection coats metal surfaces with an invisible gamma oxide film. Spray or dip it on in solution—add it to circulating water systems—combine it with phosphates for greater moisture resistance. It also reportedly suppresses degradation in aluminum, tin, monel, copper and brass.

Write for further information and a test sample.

Sodium Nitrite • Caustic Soda • Calcium Chloride • Chlorine • Chloroform Caustic Potash • Potassium Carbonate • Sodium Bicarbonate • Soda Ash Ammonium Chloride • Methyl Chloride • Ammonium Bicarbonate • Vinyl Chloride Methylene Chloride • Cleaning Compounds • Hydrogen Peroxide • Aluminum Chloride • Mutual® Chromium Chemicals • Snowflake® Crystals • Monochlorobenzene • Ortho-dichlorobenzene • Para-dichlorobenzene • Carbon Tetrachloride

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initially being produced in ½-mil thickness, giving a coverage of 50,000 sq. in./lb.

The material is being produced in a semi-commercial unit at Macedon, N. Y. Marketing will start within a few months; semi-commercial and development quantities are now available on request.—**Kordite Co., Macedon, N. Y.** 62A

Anti-Freeze

Needn't be drained from one year to the next.

Telar anti-freeze and anti-rust coolant is the first such product which can be used safely year after year—and need never be drained from a properly operating cooling system. It not only provides anti-freeze protection, but also maintains efficient cooling during both summer and winter.

Secret of Telar's staying power is a long-life chemical inhibitor that rustproofs the entire cooling system and protects all metal surfaces (including latest aluminum alloys) against corrosion. The inhibitor forms a thin layer of chemical armor on all corrosion-susceptible surfaces that makes them immune to the effects of oxidation and electrolysis. When added to a system where rust and corrosion have already begun, the inhibitor prevents further damage.

Another of Telar's outstanding features is a built-in signal that warns of major cooling systems' breakdowns before costly damage occurs. This patented feature changes the normal red color of Telar to yellow if a leaky water pump, hose connector or cylinder-head gasket lets too much air or corrosive exhaust gases into the anti-freeze solution, contaminating the coolant. If this occurs, the solution should be drained before corrosion can begin.

Unlike previous anti-freezes and pre-mixed solutions, Telar can be mixed with ordinary water. Therefore no specially prepared mixture need be sought to make up for normal losses.

Telar will be distributed through service outlets at a suggested retail price of $5/gal.—**E. I. du Pont de Nemours & Co., Wilmington, Del.** 64A

Coated Al Foil

Can be bonded permanently to woods, plastics.

Hard and softwood veneers, hard and soft plywood, phenolic- and melamine-impregnated kraft paper and plastic impregnated cloth—these are some of the many wood and plastic products to which Alcoa's new adhesive-coated aluminum foil has been permanently bonded.

When bonded integrally to these materials, the coated foil may serve as a moisture barrier, decorative element, base for paint, light reflector or heat disperser.

The new foil development incorporates the use of Dri-Line, a new type of coating developed by Polymer Industries, which chemically reacts with woods and partially cured resins to form almost permanent bonds. Since Dri-Line won't stick to any other substance or itself except under specific conditions of pressure, heat, time and moisture, aluminum foil coated with it can be readily shipped, handled and stored safely for indefinite periods of time.

Immediate markets for the new foil product are expected to be in the manufacture of hard and soft plywood, furniture panels, wall covering and plastic laminates.

Coated on one or both sides, the foil will be available in gages down to 0.001 in. and in widths up to 50 in.—**Aluminum Co. of America, Pittsburgh.** 64B

Lecithin Concentrate

Improves stability of water-based paints.

By stabilizing the emulsion, preventing pigment migration, retarding pigment settling and preventing hard pigment pack in long storage, Emultex R lecithin compound improves stability of water-based paints.

Tests with paints containing the new lecithin concentrate (a complex mixture of natural soybean-derived phosphatides) showed improved flow and working consistency, easier brush or roll out, reduced lap marks, increased hiding power and color strength, and, in some cases, reduced sagging.

In paint formulation, 1-3% of total pigment weight of Emultex R compound promotes rapid wetting and breakup of aggregates, facilitates mixing and grinding and permits reduced grinding time or increased pigment level in the premix.

Although the percentage requirement of lecithin compound

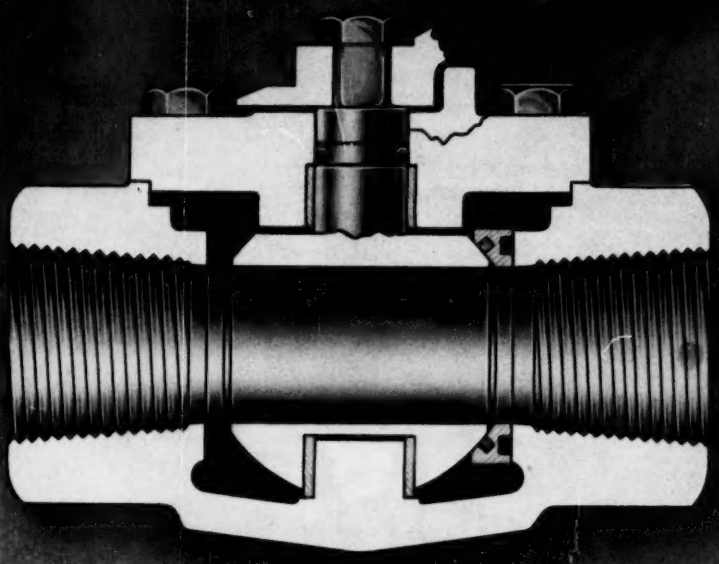
Newsworthy Chemicals

Page Number is also Reader Service Code Number

Polypropylene film promises to benefit packagers.....62A
Anti-freeze boasts real permanence.....64A
Coated aluminum foil can bond with many materials.....64B
Lecithin concentrate helps stabilize water-based paints..64C
Asphalt cuts soil-water losses in a new application.....68A
Stannous catalyst to aid urethane foam producers.....68B
High-purity indium available as convenient spheres.....68C
High-energy oxidizers to make fuels, chemicals.....68D
Combustion chemical protects air heaters, boilers.....68E

For more details, use Reader Service Card

....how can 1 valve replace 3?



Better **FLOW** *than a* **GATE...**

but, unlike gates, the *FLO•BALL* valve doesn't freeze or jam . . . it never leaks . . . the seats don't score . . . it requires no maintenance . . . and just a ¼ turn opens or closes it.

Better **SEALING** *than a* **GLOBE...**

but, unlike globes, *FLO•BALL* gives zero leakage . . . in both directions *without* seat distortion . . . closes easily without massive operators . . . gives more than twice the flow . . . and the fastest action of any valve made.

Better **RELIABILITY** *than a* **PLUG...**

but, unlike plugs, *FLO•BALL never* needs lubrication . . . never freezes, never leaks, requires no maintenance . . . yet it has greater flow capacity than any plug . . . and the *lowest* torque in the industry.

FLO•BALL® does it . . . and does it better!

Hydromatics, Inc.
LIVINGSTON, NEW JERSEY

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Mail this postage-free card today!

Bearing-fixed ***FLO•BALL*** valves are stocked with flanged or screwed ends, full or reduced port, in standard sizes from ⅛" to 10". They are made to standard ASA dimensions in carbon steel and 316 stainless steel.

Gentlemen:

Perhaps your bearing-fixed ***FLO•BALL*** valves can fill my applications. I require valves for_____

_____ in these sizes_____.

I now use ball valves in these sizes_____.

PLEASE: ☐ Have salesman call ☐ Send technical data

My name_____ Position_____

Company name_____

Address_____

City_____ State_____

...how the FLO•BALL® reduces your valve costs 3 ways!

1. Reduce initial costs . . . *by using fewer valv per system. FLO•BALL valves are used in place of gates, globe or plugs.*

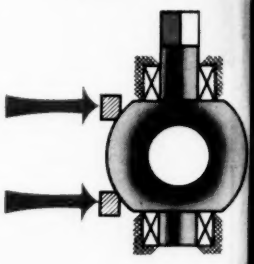
2. Reduce inventory costs . . . *by standardizi on one type valve for all applications requiring gates, globe or plugs.*

3. Reduce maintenance costs . . *the FLO•BALL high reliability means less maintenance . . . lubrication, no freezing, positive sealing. The top loading a replaceable seat reduces overhaul and start-up costs.*

Principles of Operation

In the bearing-fixed FLO•BALL valve all pressure forces exerted on the ball are transmitted to low-friction bearings. The pressure balanced seat results in a sealing force which is designed to insure positive sealing without seat distortion, and to minimize seat-resisting frictional forces. The combination of these low frictional forces accounts for the extremely low operating torque.

FLO•BALL VALVE
Fixes ball • Floats sea



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Find the "other man"!

Find the "other man" and you'll find another reason why you should come to Carlson for your stainless steel plate and other stainless products. The "other man" is an unseen crane operator. He, together with the hook-up man directing the loading of a stainless head in our shipping bay, is working "after hours" for one purpose—to assemble and ship a customer's order *fast*.

Why? The customer's production schedule may have changed suddenly. Perhaps quick delivery is needed to repair a vital piece of equipment. Whatever the reason, the customer knows he can count on Carlson for exceptional service. For Carlson is accustomed to producing and delivering, *fast*, a wide variety of high quality stainless steel products.

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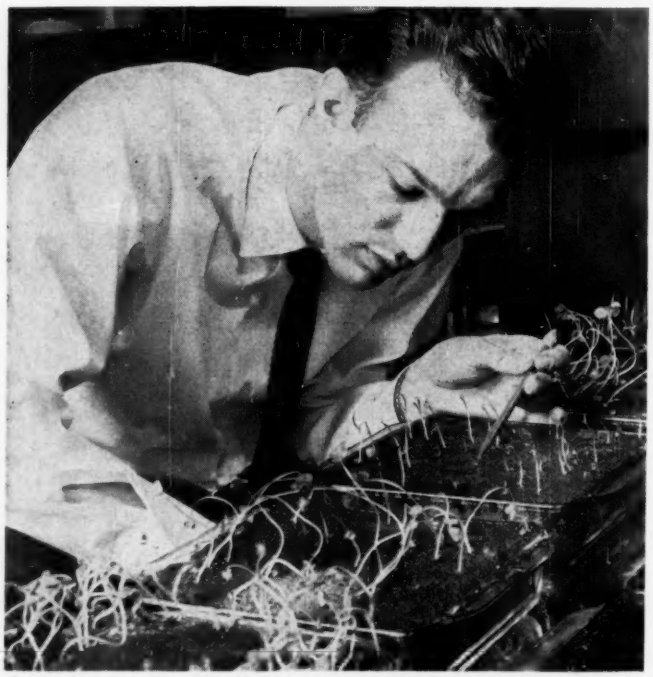

Spring Crops Grow Through Asphalt

Asphalt, a star in the road surfacing field, is now playing a newer role—facilitating the growth of crops in arid areas.

A specially developed blend of asphalt, when sprayed over seeded soil, prevents moisture in the soil from evaporating; thus helps give as much water as possible to young plants.

The strength of delicate vegetable and grass shoots—like the radishes, peppers, spinach and buckwheat being counted above—is such that they easily pierce asphalt layers as thick as 1/10-in.—Esso Research and Engineering Co., New York. 68A

varies in individual cases, higher content of active ingredients in the new concentrate suggests that less of it may be required than of other lecithin products.

Emultex R is recommended for all types of water-based paints and is compatible with the usual thickeners such as casein, soya protein or carboxymethyl cellulose.

Product is packed in 55-gal. drums containing about 450 lb. **—A. E. Staley Mfg. Co., Decatur, Ill. 64C**

BRIEFS

Stannous catalyst, T-9, gives urethane foam producers greater control in their formulations than previously available with stannous octoates. T-9's other advantages include superior storage stability and uniformity of activity. — **Metal & Thermit Corp., Rahway, N. J. 68B**

99.9995% pure indium spheres, used in forming alloy junctions in germanium transistors and diodes, are now available commercially. Advantages offered to semiconductor manufacturers include reproducible results in forming the junction to the germanium crystal; also the ability to automatically load into alloying jigs, since the sub-component can roll. Spheres range in diameter from 0.001 to 0.250 in., with diameters held down to ± 0.0001 in. and sphericity as close as ± 0.0001 in.—**Accurate Specialties Co., Woodside, N. Y. 68C**

High energy oxidizers, nitrogen trifluoride and tetrafluorohydrazine, are useful by themselves or as building blocks for the preparation of tailored compounds for specific high-energy fuel applications. Both compounds are colorless gases and colorless mobile liquids. Apart from their fuel potential, they also have indicated usefulness for development of new industrial chemicals. Pilot plant quantities available.—**Stauffer Chemical Co., N. Y. 68D**

Combustion chemical, Nalco 159, is particularly effective in protecting air heater and economizer sections of residual oil-fired boilers. It protects boiler fireside surfaces by interrupting high-temperature reactions that cause oil ash constituents to form slag. It also poisons catalytic surfaces that promote SO_3 formation. By reducing corrosion and eliminating fouling, Nalco 159 cuts draft losses, minimizes or eliminates fireside cleaning, increases boiler availability and efficiency. **—Nalco Chemical Co., Chicago. 68E**

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard (p 149)

YOU CAN READ 'BUELL CYCLONES' AS '$AVING$'

In recovering valuable dust, a slight increase in collection efficiency can amount to a significant savings in dollars. Buell cyclones provide this extra efficiency not found in ordinary cyclones. Only Buell cyclones have the unique design feature ... the "Shave-Off", which provides this plus in efficiency, stops fine dust from escaping. Savings with Buell cyclones can be very significant. In the recovery of catalyst in a large cat cracker in oil refining, for instance, 1/10 of 1% increase in efficiency results in *daily savings of $17,000* (at $250 per ton). Even with lighter dust loadings savings can be surprisingly high. Start saving today by finding out more about the extra efficiency of Buell cyclone collectors. Literature is available or we'll be glad to study the savings possibilities in your dust collection problem. Contact Buell Engineering Company, Inc., 123 William St., New York 38, N. Y. Northern Blower Div., 6404 Barberton Ave., Cleveland, Ohio. (Subsidiary: Ambuco Limited, London, England).

In an ordinary cyclone dust re-circulates in the double-eddy currents at the top, finer dust escapes. The result is erosion of the walls of the cyclone and loss of efficiency. In the Buell cyclone (as shown in the cutaway illustration) the dust at the top makes *less* than one revolution before it is trapped by the "Shave-Off". It is then channeled down to the lower portion of the cyclone, well below the clean gas outlet. Result: longer life for the cyclones, plus higher collection efficiency.

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- **CYCLONES**
- **ELECTRIC PRECIPITATORS**
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- **COMBINATION SYSTEMS**
- **FANS**
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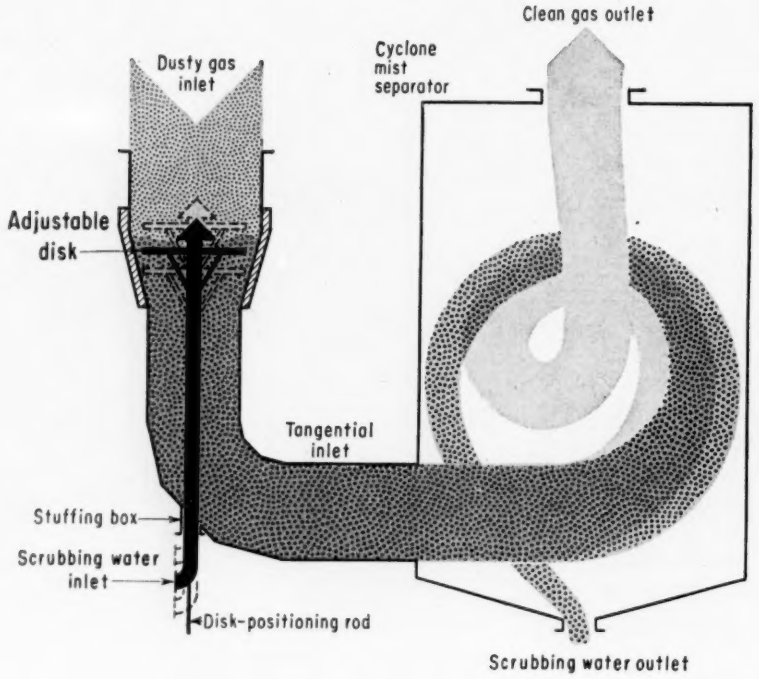


Novel Scrubber Adjusts for Variable Flows

Flooded disk operates automatically at constant pressure drop to maintain high scrubbing efficiency.

Demonstrating a flexibility which should make it a favorite with design engineers, an unusual new gas scrubber developed by Research-Cottrell, Inc., automatically adjusts to gas flows 50% above or below normal at constant ΔP while maintaining efficiency. Conventional scrubbers suffer from reduced separation efficiency at low gas flow rates and from increasing pressure drop at high rates.

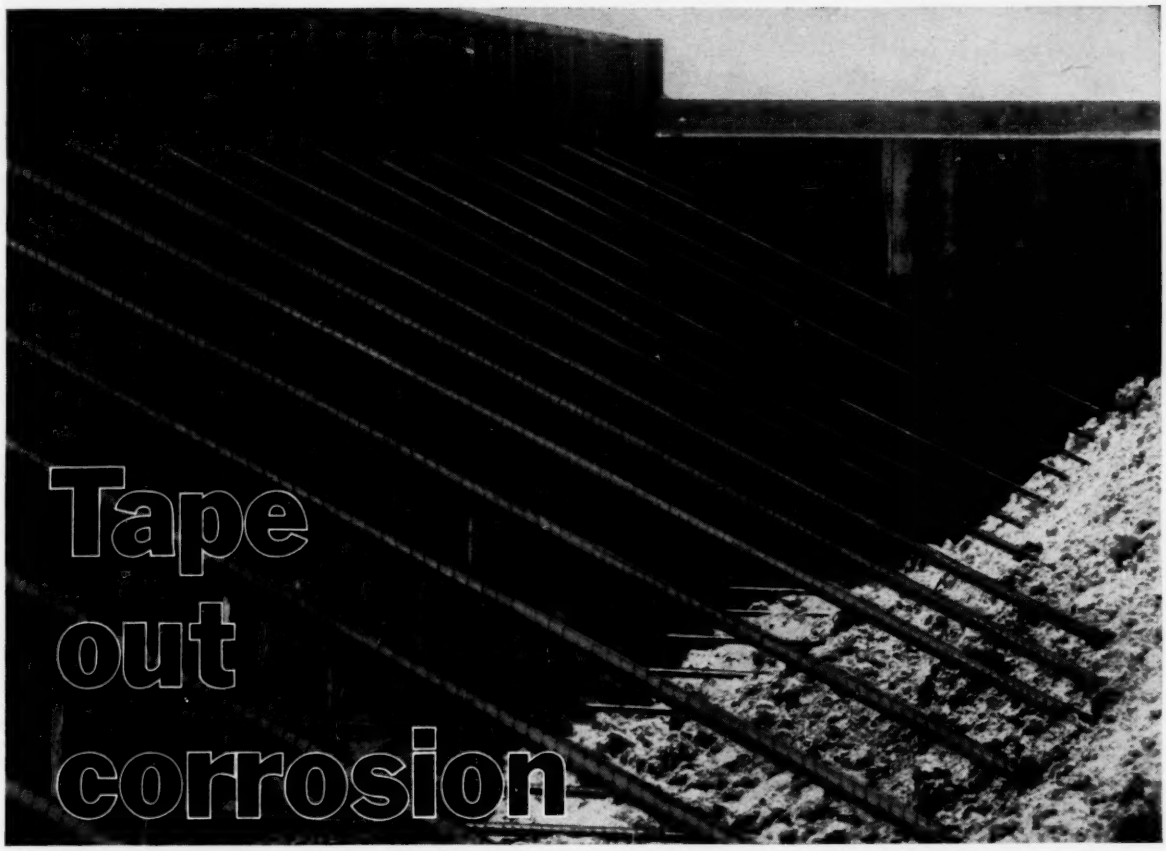
Advantages of the new scrubber include:

- High efficiency for widely varying gas flows.
- Automatic operation to maintain uniform pressure drop.
- Large water passages to permit operation with very dirty scrubbing water.
- Small floor space requirements.

Design feature of the new scrubber is a unique adjustable flooded disk centered in a conical gas duct. Upflowing scrubbing liquid impinges on a ceramic cap and flows across the disk to intimately contact downflowing gas in the highly turbulent annular zone between disk and duct.

This annular area can be greatly increased or decreased by small movements of the disk to provide a simple means of maintaining a uniform pressure drop when gas flow varies.

▶ **Micron Dust Agglomerated**—Water-dust contact essential to effective scrubbing action on submicron particles is induced by the turbulence in the annular zone. Repeated collisions within



To assure permanent support for this seawall on Lake Michigan, a Wisconsin building contractor wrapped his anchor rods in Polyken tape. Even with an abrasive backfill of wet cinders and ashes, this builder knows Polyken will prevent corrosion and help protect buildings behind the wall.

with permanent Polyken

The durable, doubly thick adhesive of Polyken tape seals all voids—seals out corrosion

Tough, long-lasting Polyken Protective Coatings keep air and moisture from the metal. And abrasion has little effect.

Try Polyken in your plant. Get complete protection for your pipes, conduits, rods—almost anything cylindrical. Polyken is made of an inert polyethylene, with an unplasticized, non-drying film. The unusually high adhesive bonds the coating to clean surfaces without a primer.

Maintenance costs are considerably lower than with paint. Polyken goes on quickly, economically, right from the roll. No heat, no solvents or thinners, no drying or clean-up time. And keep in mind Polyken's lower water vapor transmission rate, higher electrical insulation resistance and better cold-weather handling and durability.

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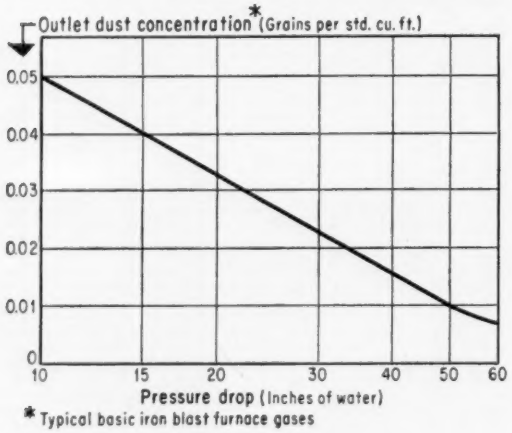
See your Polyken representative or call the Polyken tape coating distributor near you. Or simply write Polyken, 309 West Jackson Blvd., Chicago 6, Ill. (In Canada, write Polyken, Curity Ave., Toronto.)

Polyken®

EXPERIENCED IN PROTECTIVE COATINGS

THE KENDALL COMPANY
Polyken Sales Division

Outlet Dust Loading Drops at Higher ΔP.



the dust-water mixture form agglomerates which can be removed easily in a conventional cyclone separator.

Automatic operation of the unit is maintained by monitoring the pressure drop across the disk to detect variations in gas flow rate. Any change in ΔP automatically actuates a pneumatic or hydraulic operator which repositions the disk to restore the ΔP to its pre-set level.

Rates of gas flow from open hearth, oxygen converter and blast furnace vary considerably during their operating cycle. New scrubber should find natural application in this service or for general dust scrubbing duty where variable gas flows are encountered.

Operation of the disk scrubber was demonstrated using a small blast furnace as a dusty gas source. Gas flows at 400 F. varied from 1,000 to 2,000 cfm. with inlet dust loadings up to 5 grains/ft.^{3}

Water circulation rate was 5 gpm./M cfm. with a makeup rate to the effluent system of about 1 gpm./M cfm. Outlet dust concentrations (see chart) of 0.05 to 0.01 grains/ft.^{3} were obtained for pressure drops across the unit of 10 to 50 in. of water to give collection efficiencies of 99.0 to 99.5%.

► **Other Advantages** — Maintenance and downtime are negligible on the flooded disk system since there are no restrictions or nozzles to plug up from particles in the effluent system. Very dirty water can be constantly recirculated; effluent volume is thus minimized with a resultant reduction in the size and cost of effluent treatment equipment and savings on makeup water.

Areas subject to abrasion are limited to the disk and cone so the amount of abrasion-resistant materials is reduced. Design eliminates the need for long converging and diverging flues, renders the unit compact so it requires less plant space. With automatic control applied, flooded disk operates at high efficiency without personnel attention.

Constant pressure-drop operation also insures against pressure upsets in the system, reduces the need for higher blower capacity required by conventional equipment for higher gas flows, reduces blower installation and power costs. — **Research-Cottrell, Inc., Bound Brook, N. J.** **70A**

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

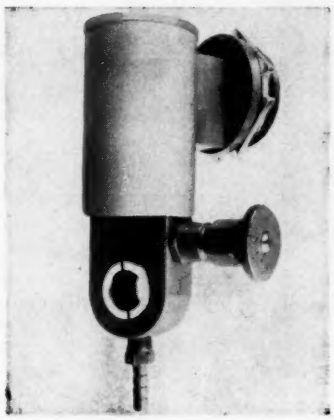
postcard (p. 149)

Peak Recorder

Makes continuous record on slow-moving chart.

Hours of stream analysis can be studied in the window of a new recorder which selects peak heights from a process gas chromatograph. Points are successively numbered on slow-moving chart to permit easy recognition of analysis change.

Model 6707 has one set of input terminals and multipoint printing head. Pointer drives upscale until detector senses signal peak, activates printing head. Special feature safeguards against false peaks and periodically synchronizes recorder with chromatograph.— **Weston Instruments Div., Daystrom, Inc., Newark, N. J.** **72A**



Constant-Head Feeder

Feeds set rate from drums despite varying head.

New gravity metering device attaches directly to standard 2-in. drum bung, feeds liquids from drum at set rate regardless of liquid level. Molded of teflon and PVC, it can also be used for vacuum line feeding.

Flow rate, set by sight-metering, can vary from 1 drop/min. to 10 gal./hr. Special locking ring makes drum changeover possible without tools.— **Sterling Norcross Co., Bloomfield, N. J.** **72B**

Equipment Developments continues on page 74.

Trainees using Rockwood Double Strength FOAM liquid learn one of the most effective fire-fighting techniques ever developed. Training cost is low because 3 gallons of FOAM provide 1,000 gallons of extinguisher.

Training men with Rockwood FOAM costs you least, saves you most

Rockwood Double Strength FOAM liquid gives you more efficient fire protection at lower cost than any other fire extinguishing agent. By mixing only 3 gallons of FOAM liquid with 97 gallons of water and 900 gallons of air you get 1,000 gallons of a powerful fire-fighting mixture — *the cost of which, per gallon, is only three tenths of 1% of the cost of FOAM.*

Double Strength FOAM liquid helps you improve and economize your departmental training too. The very small proportion required to produce this extinguishing agent permits training under actual fire conditions at negligible cost.

For further facts on Rockwood Double Strength FOAM, tested and listed by Underwriters' Laboratories, Inc., send coupon today.

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Long and Short Of It.

Once-inaccessible areas in deep vessels or ducts now yield their temperature secrets to new stainless-steel dial thermometer with 6-ft. stem. Hand calibrated for accuracies within 1% of full scale reading, thermometer can withstand pressures up to 3,475 psi.

Unit is available in temperature ranges of 0-200 F. to 200-1,000 F., or with similar Centigrade calibrations. Dial sizes range from 1$\frac{1}{2}$ to 5 in.—W. C. Dillon & Co., Van Nuys, Calif. 74A

Strong Filter Media

Coated fiber-glass sheets are tough and uniform.

Filter fabric comprised of woven glass mesh impregnated with teflon or Sylkyd resins is now available. Called Amfab, new fabric is heat and chemical resistant, has high tensile and burst strength. Porosity range of 1 to 75 microns is closely controlled to give desired filtrate clarity. Thin (0.001 to 0.025 in.), inert medium makes for high filtration rates, easy cake removal.

Made in 36 in. widths, Amfab is tougher than thinner Fiberfilm sheet also produced by same manufacturer. Fiberfilm is formed from blended glass fibers arranged by special process to give uniform porosity, is also coated to give superior performance. — **American Machine and Foundry Co., Amflex Products Dept., Springdale, Conn. 74B**

Epoxy Spray Gun

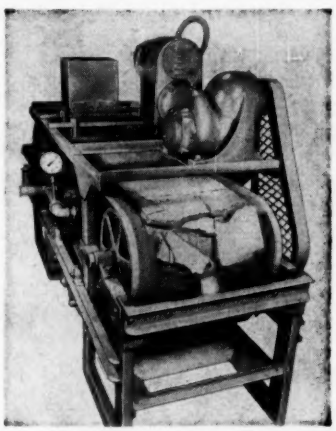
Sprays coating materials of trowel consistency.

Corrosion-resistant, thermosetting epoxy coatings can now be applied by spraying with a new high-volume air gun. Called Quikspray, the gun sprays materials of trowel consistency on floors and walls three to ten times faster than conventional application methods.

Portable and easily cleaned, unit has snap connections for standard air hoses, interchangeable orifices with rubber inserts. Standard gun includes two aluminum cone-shaped hoppers so that mixing and spraying can proceed without interruption.

Power for the rotary-type compressor is provided by a 2$\frac{1}{2}$ h.p. gasoline engine or a $\frac{1}{2}$ h.p. electric motor. Using either pressure or gravity spray units, gun can cover 600-1,000 sq. ft./hr.

Other materials which the gun will spray include acoustical plasters, stucco, sand finish plasters, aluminum-filled roof coatings, epoxy-based materials, and latex-based materials.— **Pennsalt Chemicals Corp., Natrona, Pa. 74C**



Straight Line Filter

Moving belt seal requires no movable valves.

New straight line horizontal filter has sectionalized drainage belt which also seals to vacuum box, eliminating movable valves.

Filter media rides on ridged rubber belt which channels filtrate to center holes. Holes extend through heavy ridge on bottom of belt, discharge filtrate into vacuum box. Sliding seal is made between bottom ridge and top of vacuum box.

Divisions in vacuum box, which permit different vacuum levels and separation of filtrates, are adaptable for countercurrent washing. An entirely separate blow-off chamber prevents blowback of filtrate.

Filter cake forms by gravity and vacuum drainage on horizontal run, discharges off end roller. Rubber belt and filter media separate on return run so media can be washed on both sides. Bottom ridge on belt rides in grooves on end rollers to assure constant belt alignment.

Entire filtration cycle from feed to filter cake discharge is

EQUIPMENT NEWS Continues on . . . Page 135

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U.S.I. CHEMICAL NEWS

May ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1960

New Electronic Process Is Said to Protect Steel From Many Corrosives

Sulfuric, nitric and phosphoric acids, caustic soda, aluminum sulfate, ammonium nitrate—these are some of the corrosive materials said to lose their sting indefinitely in steel vessels which have been subjected to anodic passivation techniques developed recently.

In the process, an electrode system and a newly developed automatic potential controller are used to form an extremely thin, oxygen-containing film over the steel, and to control this protective film electrically. The process was plant tested for a year, and it is claimed that corrosion in equipment during that period was completely eliminated.

In general, the process is said to be applicable to the oxy acids, bases and salts. The major class of electrolytes excluded are solutions containing halogens. It is reported that control can be established in very complex geometrical vessels, in flow lines, and at temperatures as high as 500° F.—by application of almost negligible currents. The developers of the process say that they can, by laboratory studies, predict the current and voltage requirements for anodically protecting any process or storage vessel.

New Sodium Peroxide Data Sheet Available from U.S.I.

Specifications, typical analysis, properties, shipping data and uses of U.S.I. sodium peroxide are included in a new technical data sheet now available from the company. The compound, which is used widely by the pulp and paper and textile industries for bleaching purposes, also has important applications in making organic and inorganic peroxygen compounds, in bleaching fats and oils, and in processing certain ores.

The new data sheet also offers technical service on sodium peroxide handling and use from U.S.I.'s staff and comprehensive laboratory facilities. For your copy, contact your nearest U.S.I. sales office or address Technical Literature Department, U.S.I. Chemical News, 99 Park Ave., N. Y. 16, N. Y.

New Aerosol Valve Can Operate at Any Angle

A new patented valve arrangement for aerosol containers allows operation at any container position by providing a by-pass to the dip tube which functions when the container is tipped. In an upright position, the by-pass is closed by a slider and the valve operates in the same way as any other—liquid being forced up the dip tube by propellant pressure.

In any inverted position, however, the slider falls away, the by-pass portion of the valve opens and the liquid, instead of going through the dip tube, flows into the by-pass and out through the conventional portion of the valve. The patented valve is essentially an adapter which may be used with some existing aerosol valves. Manufacturing licenses are being offered by the developer to valve producers in this country and abroad.

U.S.I. Introduces "MICROTHENE" Finely Divided Polyethylene

Resin in Powder Form Expected to Expand Use of Polyethylene In Textile, Paper, Metal, Chemical Specialty and Other Fields

Polyethylene in finely divided or powdered form is now being produced by U.S.I. and is available in sample and semi-commercial quantities under the tradename "MICROTHENE". Already in use in Europe, finely divided polyethylene is expected to open many new markets for the resin in this country and to expand a number of existing ones. Some of the applications forseen include its use as an additive in chemical specialties such as waxes and polishes, in the coating of metal, textile, paper, glass and wood products, as a binder for non-woven fabrics, and as molding powder for production of large polyethylene items such as boats, tanks, and shipping drums.

Methods of Application

In coating operations, MICROTHENE polyethylene can be applied to the substrate in its original powder form, as an organic or aqueous dispersion, or as an organic or aqueous paste. The method selected depends largely on the substrate to be coated, the major requirement being that the substrate be able to withstand the heat necessary to fuse the resin into a continuous coating. In the coating of woven and non-woven fabrics, dry polyethylene powder or a paste is generally spread evenly onto a moving web, which then passes through an oven to sinter the plastic into a film coating. Metal parts can be coated by spraying, dipping, or slush coating with either the dry powder or dispersions. Organic dispersions are generally used on metals that would be corroded by water. With modifications of application techniques, strippable polyethylene metal coatings may be possible.

Fluidized Bed Technique

Irregularly shaped objects, wire, and other metal items can also be coated with inex-

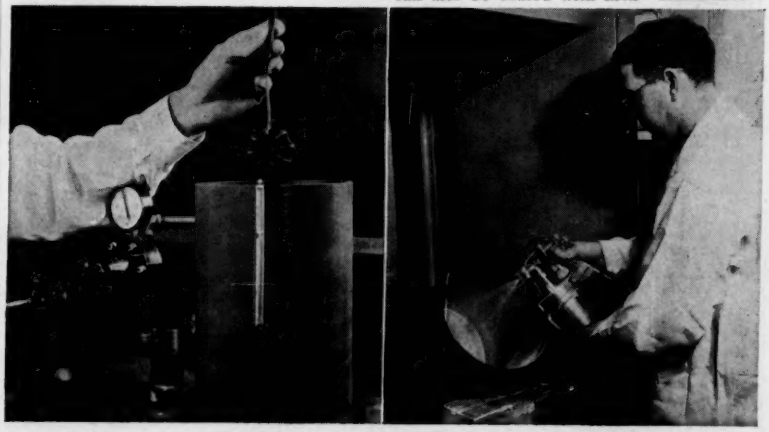
MORE

Healing Agent Solubilized By Ethanol in Aerosol Hair Sprays, After-Shaves

It has been suggested that panthenol—the alcohol analog of the B-complex vitamin pantothenic acid—be incorporated more widely into toiletry preparations because of its healing action with wounds, lesions and skin disorders generally. The material is a stable, biologically active form of pantothenic acid—one of the vitamins essential for growth and normal maintenance of skin and hair. It is said to be free of sensitation and irritation problems, and can be adsorbed topically to yield pantothenic acid in the body.

The following are two examples of formulations incorporating the healing agent:

(1) After-Shave Lotion	
d-Panthenol	0.500%
Quaternary ammonium salt	0.250%
ALCOHOL (SDA-40)	40.000%
Menthol	0.005%
Ethyl p-aminobenzoate	0.025%
Distilled water	59.220%
Perfume	q.s.
Color	q.s.
(2) Aerosol Hair Spray	
d- or dl-Panthenol	1.0%
Water-soluble lanolin	0.5%
Antistatic agent	0.1%
Perfume	q.s.
ALCOHOL (SDA-40)	28.4%
Propellants	70%



Two methods for coating metal with MICROTHENE finely divided polyethylene are shown above. Hot object is dipped in fluidized bed of MICROTHENE, left. Resin dispersed in organic liquid is applied by ordinary spray equipment, right.

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May ★ **U.S.I. CHEMICAL NEWS** ★ 1960

CONTINUED

Polyethylene

pensive equipment employing the fluidized bed technique. The item is first preheated, dipped into a container with the fluidized dry powder, and then cooled or post-heated to achieve a smooth, continuous coating.

Plastic Moldings

Another potential market for MICROTHENE finely divided polyethylene is in the field of large plastic moldings. The powder is poured into heated molds which shape the polyethylene as it melts on the surface of the mold. Excess powder is then poured out. The molds required are extremely simple and inexpensive. Large containers, drums, and even small boats have been made successfully by this technique in Europe.

Production Facilities

U.S.I. is now producing MICROTHENE polyethylene at Tuscola, Illinois, site of one of U.S.I.'s two polyethylene plants. The MICROTHENE plant, which went on stream in March, has an initial capacity of 2 million pounds per year and is designed for fairly rapid expansion.

Technical Data Sheet giving detailed application information may be obtained by writing to Technical Literature Department, U.S.I. Chemical News, 99 Park Ave., N. Y. 16, N. Y. Samples are also available.

Sodium Cools Compact Reactor for Satellites

A miniature, sodium-cooled nuclear reactor, easy to scale up from 3 to 30 to 300 kw. with relatively little change in weight or size, has been developed to power communications systems in manned or unmanned satellites.

The 3 kw. version, which can power intermittent broadcasts from an unmanned satellite to the earth for as long as a year, could easily be lifted by present-day rockets. The reactor itself weighs only 220 pounds. Add an auxiliary power unit and the necessary shielding for an unmanned satellite, and the complete package weighs only 900 pounds. Larger rockets, promised for 1964, will be able to lift a *manned* satellite containing the reactor in its 3 or 30 kw. versions.

The reactor is relatively low in cost because it is fueled by uranium blended with zirconium hydride for slower burning. This fuel is contained in fuel elements in the reactor core. Liquid sodium coolant enters the core at 1,000° F., exits at 1,200° F., and transfers heat to a mercury loop. The mercury vaporizes to drive a small mercury vapor turbo-generator.

Although not completely finished yet, with the detailed engineering still to be worked out, this compact, sodium-cooled reactor is thought to be, at the moment, the most likely unit for powering communications in space.

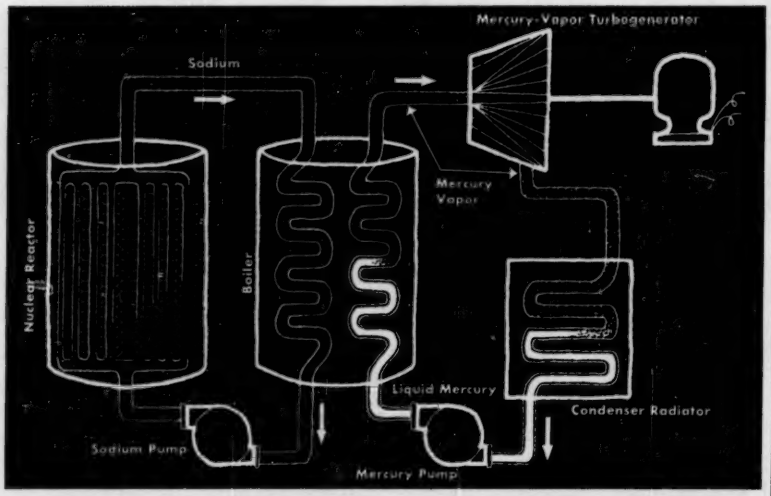

Diagram courtesy of Business Week magazine.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Analytical biochemistry is subject of new international journal now being published to serve biochemistry, biophysics and related areas of experimental biology. Devoted solely to papers describing methods in this area. **No. 1590**

Aerosol chromatography reagents now available from one source include aniline hydrogen phthalate, *p*-anisidine hydrochloride, bromcresol green, ferric chloride, isatin, ninhydrin. **No. 1591**

Protective coating now on market is said to remove rust chemically and to place a protective film over the surface—all in one operation. Can be applied to clean or rusted metal or previously painted surfaces, it is claimed. **No. 1592**

Research quantities of these chemicals are now available: hexanitroethane, trinitromethane, trinitroethanol, tetranitromethane, ammonium nitroform, potassium nitroform, hexanitrodiphenylamine, trinitrophenylmethylnitramine. **No. 1593**

New silicone fluids now available are unusually compatible with diversity of materials. Soluble in many aliphatic hydrocarbons, lower alcohols including ethanol; self-emulsifiable in water. Suggested for paints, cosmetics, other. **No. 1594**

Ammonium sulfate in a specially purified grade, designed for use as a reagent in enzyme research, is now being supplied. Product is said to have extremely low heavy-metal analysis, and to need no recrystallization. **No. 1595**

New magnetic stirrer capable of mixing and stirring solutions in as many as six vessels at one time has been announced. Solves problem of stirring several vessels simultaneously, at the exact same speeds. **No. 1596**

Seventh edition of the Merck Index, standard chemical reference book, can now be purchased. New edition has added tables in appendix, many expanded tables of data, 1600 new monographs on specific chemicals, many other additions. **No. 1597**

Report on sulfathiazole lozenges for preventing colds indicates that in a 6-year controlled study with 3,832 subjects, incidence of respiratory infections was ca. 15% in those using lozenges, ca. 57% in those not using them. **No. 1598**

Complete, low-cost radioisotope laboratory for teaching radioisotope applications in high schools and colleges is described in new bulletin. Lab consists of system of instruments, radiochemicals and lab accessories. **No. 1599**

PRODUCTS OF U.S.I.

PETROTHENE®...Polyethylene Resins

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Pharmaceutical Products: DL-Methonine, N-Acetyl-DL-Methonine, Urethan USP, Intermediates.

Heavy Chemicals: Anhydrous Ammonia, Ammonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions, Phosphatic Fertilizer Solution, Sulfuric Acid, Caustic Soda, Chlorine, Metallic Sodium, Sodium Peroxide.

Ethyl Alcohol: Pure and all denatured formulas; Anhydrous and Regular Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL®M, ANSOL PR.

Animal Feed Products: DL-Methionine, MOREA® Premix (to authorized mixer-distributors).

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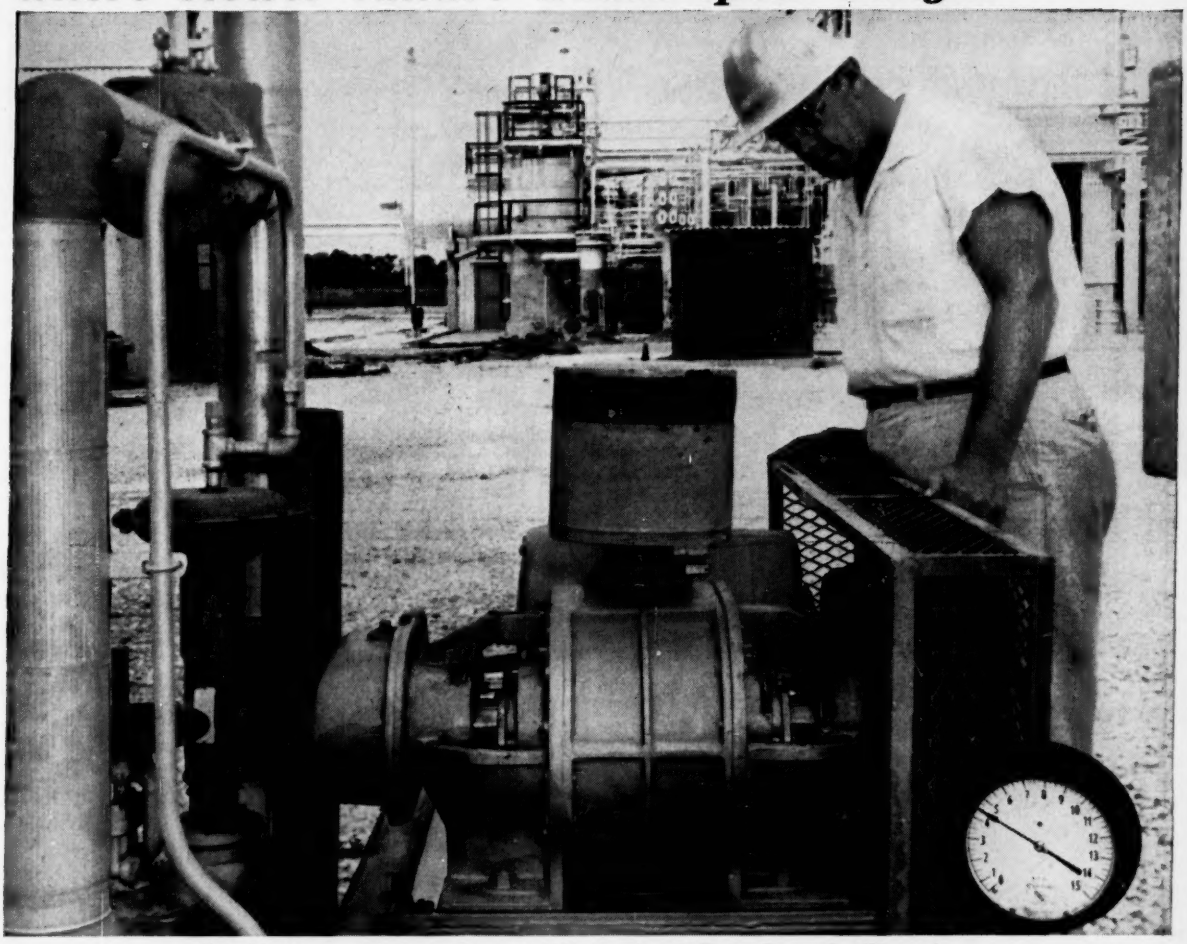

Sutorbilt blower at Polymer Chemicals Division plant in Baton Rouge, La. Blower is required at a critical phase of catalyst activation in a new Phillips-type polymerization process.

W. R. GRACE DEPENDS ON A SUTORBILT ROTARY, POSITIVE-PRESSURE BLOWER

At W. R. Grace & Co.'s new Polymer Chemical Division, the catalyst for a new, high-density polyolefin production process must be protected in a pressurized air stream. A doubly-dependable Sutorbilt rotary positive-pressure blower was selected for these three important reasons:

1. Contamination must be avoided
Long-lasting, air-tight, Teflon seals and lack of lubrication in compression chamber prevent air contamination in a Sutorbilt blower.

2. Breakdowns would be dangerous
Simple, rugged, precision construction (only rotors and bearings move) means reliable service. Unit chosen by Grace has been in continuous operation for well over a year without repairs.

3. Pressure must be positive, constant
The two, counter-rotating "figure eight" Sutorbilt impellers produce a positive-pressure, *metered* air supply.

Sutorbilt blowers and gas pumps are precision-built to deliver air or gas in capacities up to 20,000 cubic feet per minute—at pressures up to 10 pounds. Write today for complete, illustrated literature on these efficient, dependable blowers. 1349 S-16

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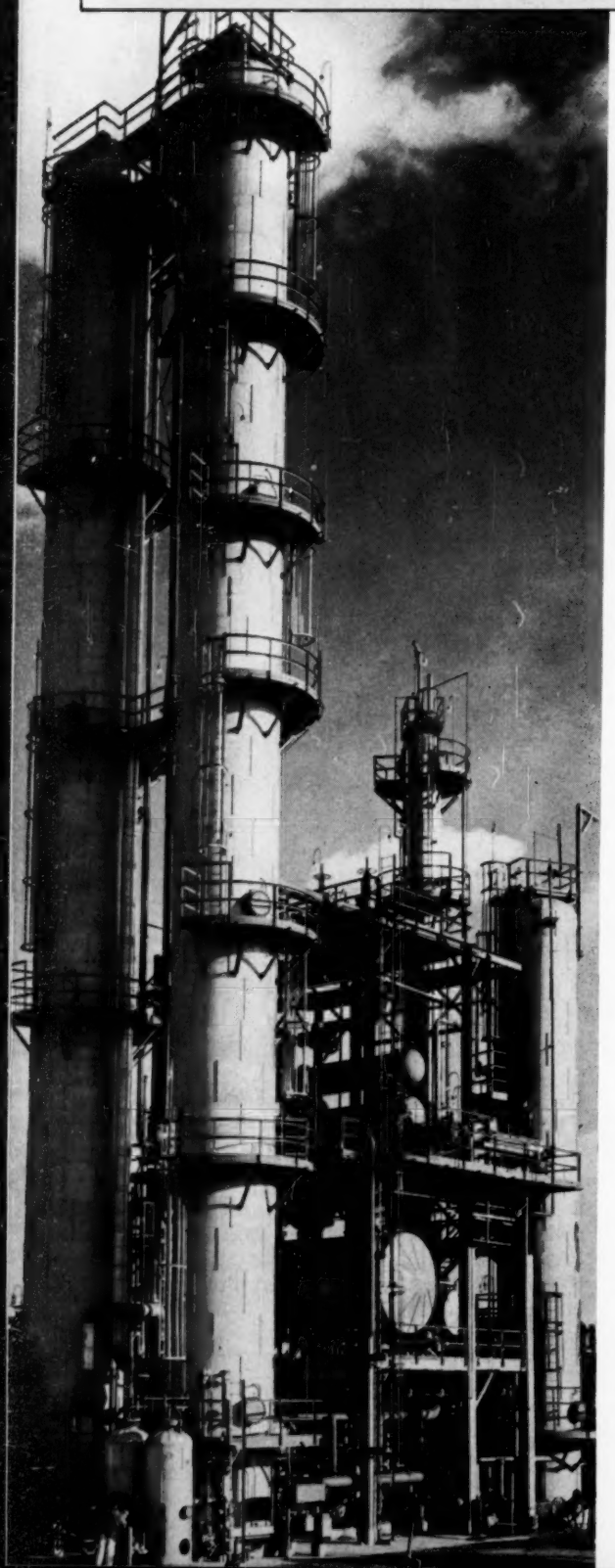


Pure Propylene Feeds Growing New Resin Industry

Representing a confident bet on the future, as well as an attractive route for upgrading the value of cracker overhead stock, Sun Oil Co.'s new $2 million propylene unit at its Marcus Hook, Pa., refinery waits in the wings for the polypropylene market to start mushrooming. The 120-million lb./yr. plant, now idling at about 1/6 of rated capacity, puts out a product having the extreme purity needed to make polypropylene resin.

The unit has been operational since November 1959. Main customer is AviSun's 20-million-lb./yr. polypropylene plant at Port Reading, N. J. AviSun is now planning a large increase in capacity, either at Port Reading or at another site.

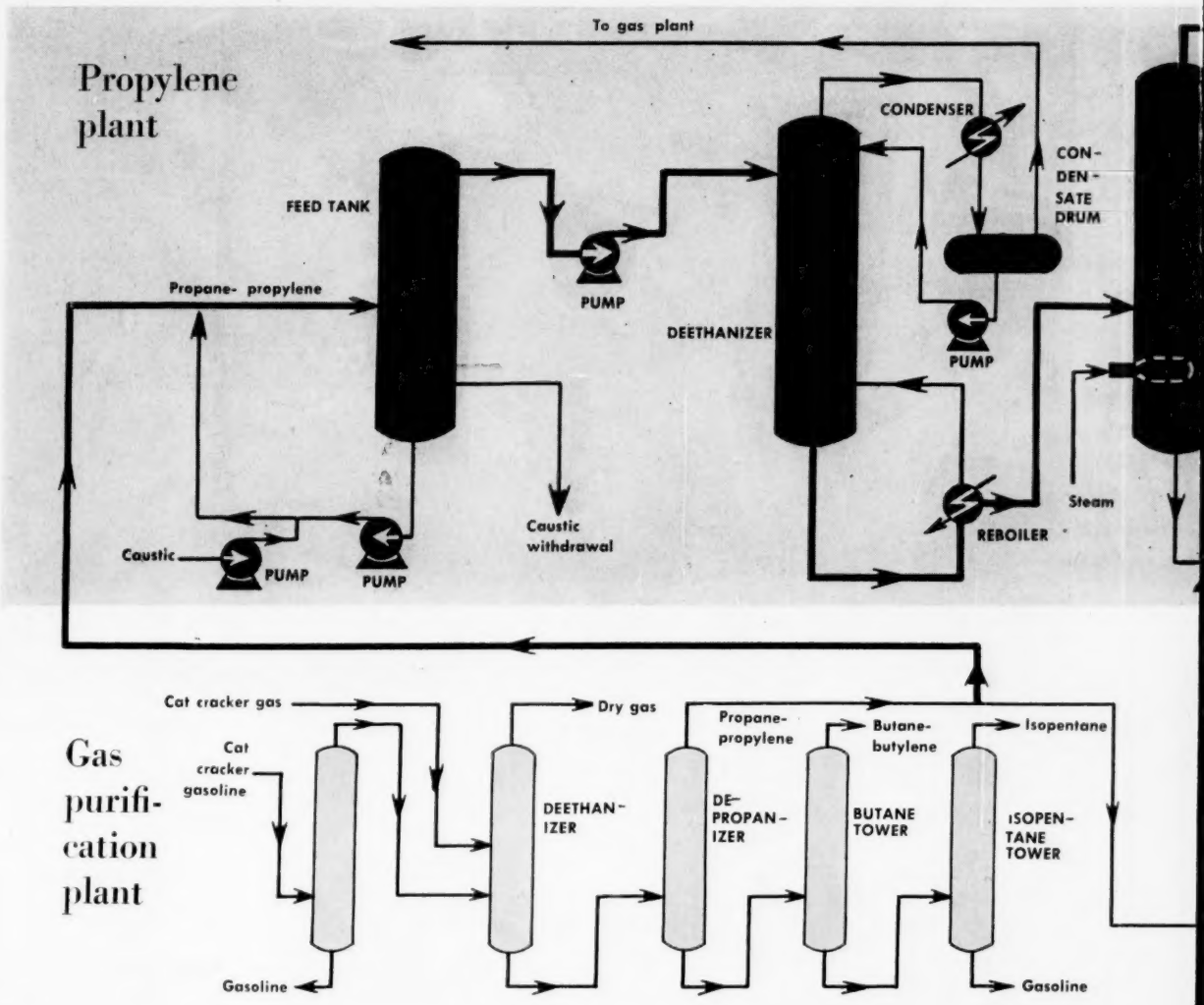
Price for propylene monomer will apparently level out around 4½¢/lb., as a host of other companies (Humble, Mobil Oil and Phillips, to name a few) prepare to join Sun and pioneer Sinclair as producers of the high-purity olefin.

▶ **Old Stream, Newer Spec**—Most of the propylene produced in refineries is alkylated or polymerized to give gasoline components. There are also some well-established uses for the material in chemicals manufacture, notably in making isopropanol and propylene oxide-glycol. Propylene for consumption in these processes need not be of particularly high purity; usually it is taken from a refinery stream containing roughly 50% propane.

Propylene also figures prominently in some newer, more glamorous, processes. These include manufacture of acrylonitrile, allyl chloride, acrolein, and oxo alcohols and aldehydes, in addition to polypropylene. Most of these require a cleaner

◀ **TALL TOWERS split pure propane-propylene stream, following caustic wash, de-ethanizing in equipment at rear.**

Unfold Flowsheet



propylene stream than is normally available.

But the most stringent purity requirements are those imposed by polypropylene production. The process uses a monomer which must be 99+% pure, and considerably purer as regards unsaturated contaminants which could smuggle themselves into the polymerization reaction.

The high-grade Marcus Hook product is tailor-made for polymerization. But, Sun officials aren't closing their eyes to other outlets. One possibility: use as raw material for polymerization-grade isoprene.

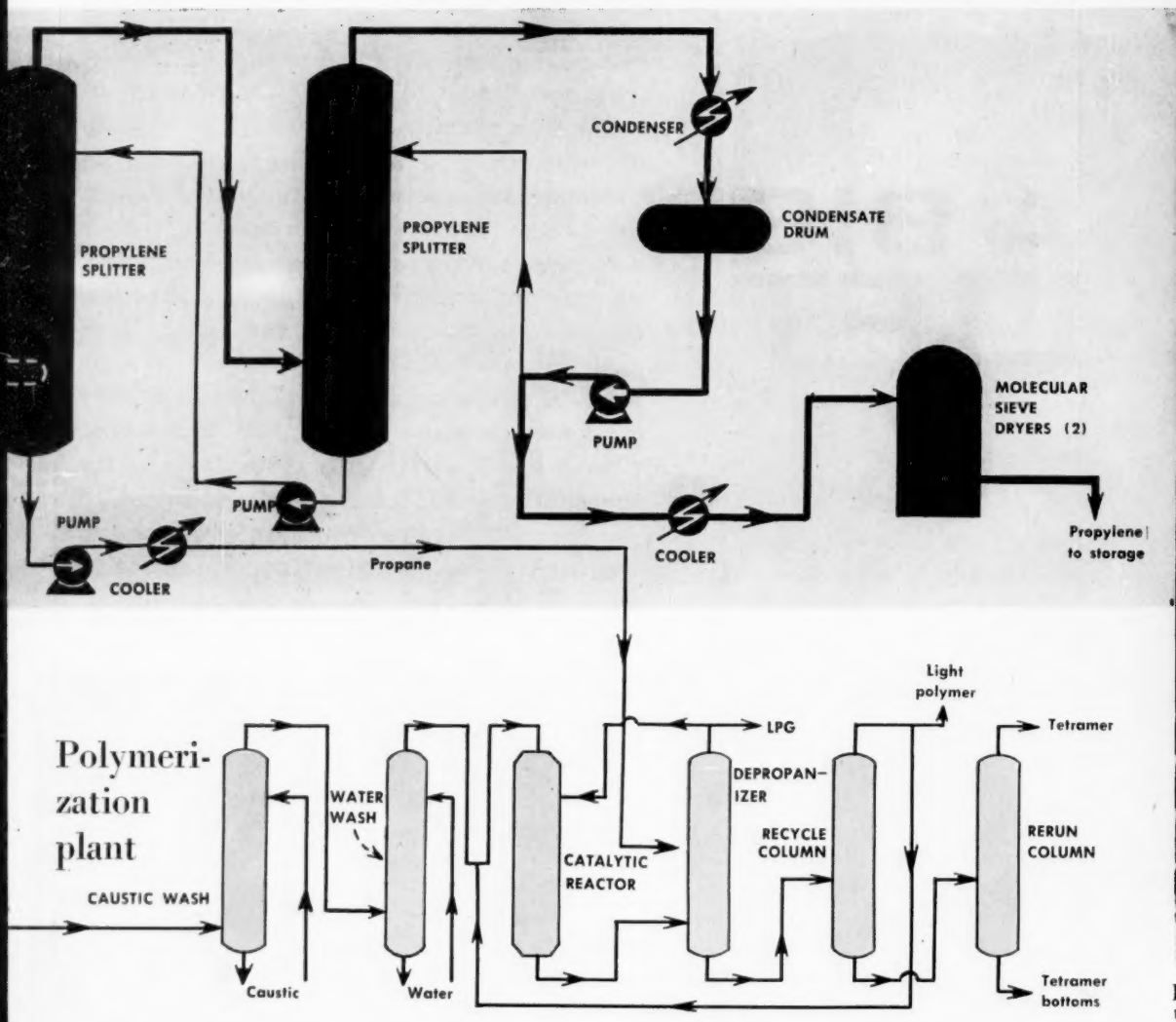
▶ **The Big Picture**—The usual sources for refinery propylene are cracking operations. At Marcus Hook, overhead and gasoline from catalytic crackers are initially fed to gas purification. Products from the purification step include stabilized gasoline, isopentane stock, a butane-butylene mixture, and a propane-propylene stock.

Typical composition of the latter stream is 2% C_2's, 42% propylene, 53% propane and 3% C_4's. Its normal destination is a polymerization plant, which produces poly gasoline, propylene tetramer and LPG. Now, however, a portion of the stream feeds to the new propylene unit.

▶ **Focusing on Propylene**—The propylene plant is relatively straightforward, and the main problem it posed for Sun engineers was compliance with a hurry-up design and erection schedule. (Sun started its process design in May 1959; the plant was built and operating six months later.)

First step consists of caustic-treating the liquefied propane-propylene mixture in a feed tank 9 ft. dia. by 60 ft. high, where the material is at 200-250 psig. Caustic solution removes sulfur compounds, and is withdrawn periodically.

The treated mixture passes to a fractionating tower for removal of C_2's. This de-ethanizer



FIXED-BE
under 5 ppm.

is 4½ ft. dia. by 86 ft. high, and is equipped with 40 valve trays. It operates at 450 psig., which represents a compromise between best C_2 removal and low loss of C_3's to the overhead stream. Non-refluxed portion of the overhead, which comes off at about 120 F., is sent back to gas purification.

▶**Feature Attraction**—De-ethanized bottoms are sent to a propylene splitter, which is (at least visually) the dominant feature of the unit. Splitting propylene from propane requires 140 trays—again valve trays are used—which Sun has placed into two 10-ft. dia. by 132-ft. high towers connected in series. Propane and butane are withdrawn as bottoms from the upstream tower; propylene leaves as a 120 F. overhead product from the second tower. Splitter operating pressure is about 300 psig.

Bottoms mixture is routed to the refinery polymerization plant. The propylene stream is dried in fixed-bed molecular-sieve dryers having dual chambers. Working dimensions of these units are 3½ ft. dia., 6 ft. high.

To save ground space, Sun has gone to tall, narrow tankage for the finished propylene, resembling processing units and providing a striking contrast to conventional spheroidal light ends storage facilities in the vicinity.

▶**Knifelike Splitting**—The large number of trays needed for propane-propylene splitting is due to the small difference in boiling points of the two materials (about 15 F. spread, at splitter pressure conditions). This difference is too small to allow process control by temperature measurement.

Instead, Sun has gone to gas chromatography, with measurement points on the feed, overhead product, bottoms product and "intermediate" overhead streams of the splitter. Two instruments are used—one of which was designed by Sun's

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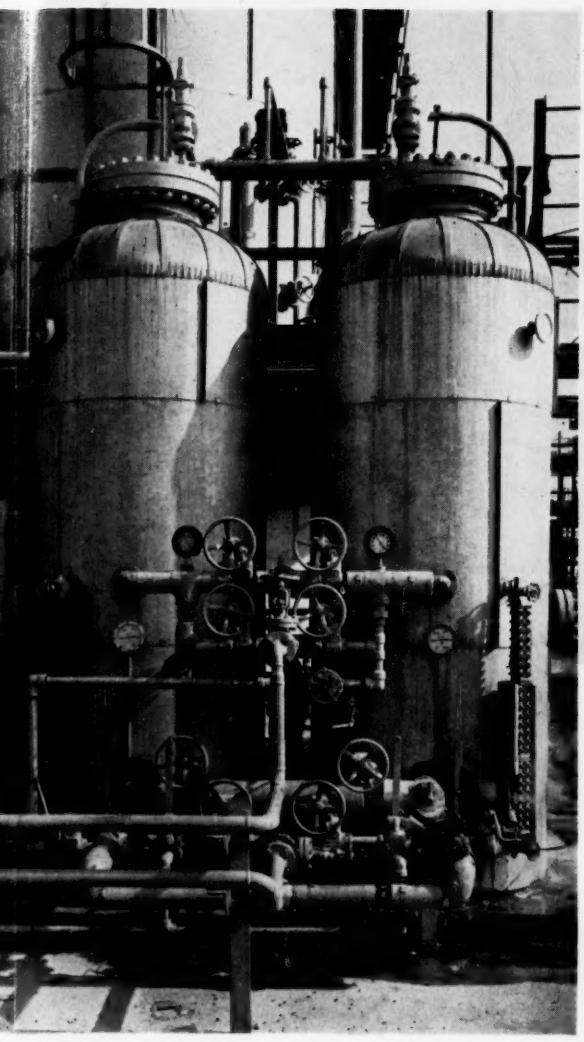
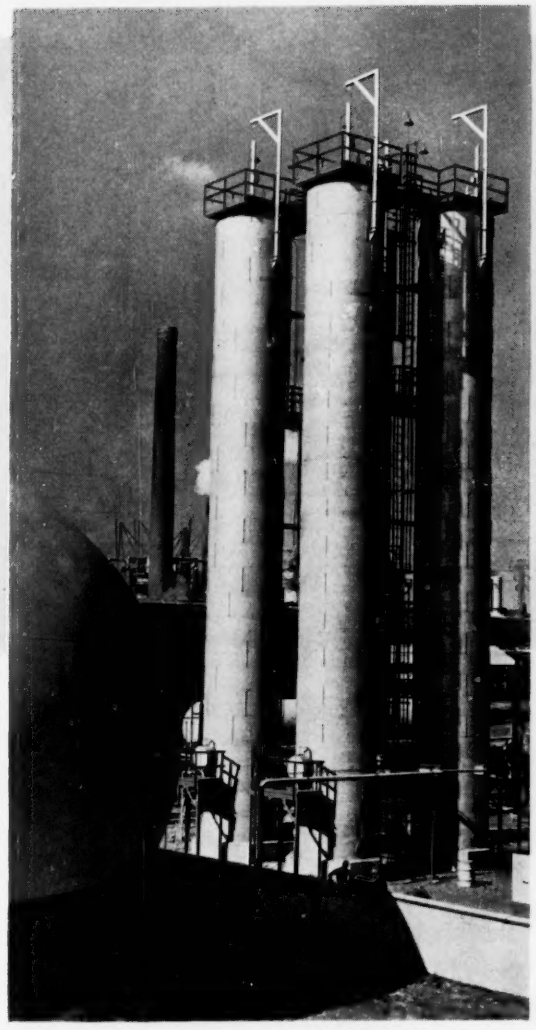


IXED-BED molecular sieve units dry propylene product to nder 5 ppm. water. External system reactivates sieve material.



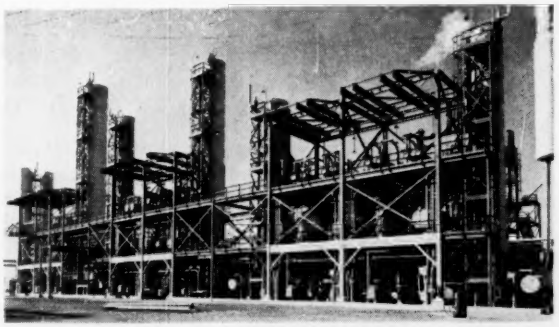
VERTICAL VESSELS hold finished product, require less ground area than conventional tank in foreground.

own applied physics staff—which give readings on 10-min. cycles.

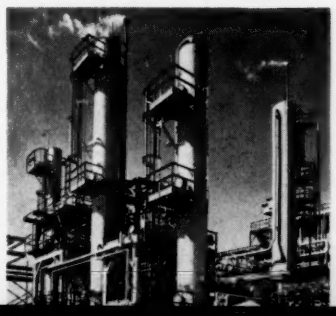
Chromatographs determine concentrations of propylene, propane and ethane, and the results are used as a guide for setting reflux conditions. Sun hopes that eventually this control process can be made automatic. Ethane concentration is measured to provide an indication of ethylene content, which is harmful at levels too low to be measured chromatographically.

▶ **Good and Clean**—Sun's product falls well within the high-purity category. Composition is said to be about 99.5% propylene, 0.5% propane. Monoolefins other than propylene are reported as 0 ppm., ethane at 100 ppm., sulfur at 4 ppm., and sum of H_2O, O_2, N_2 and CO_2 around 45-50 ppm.

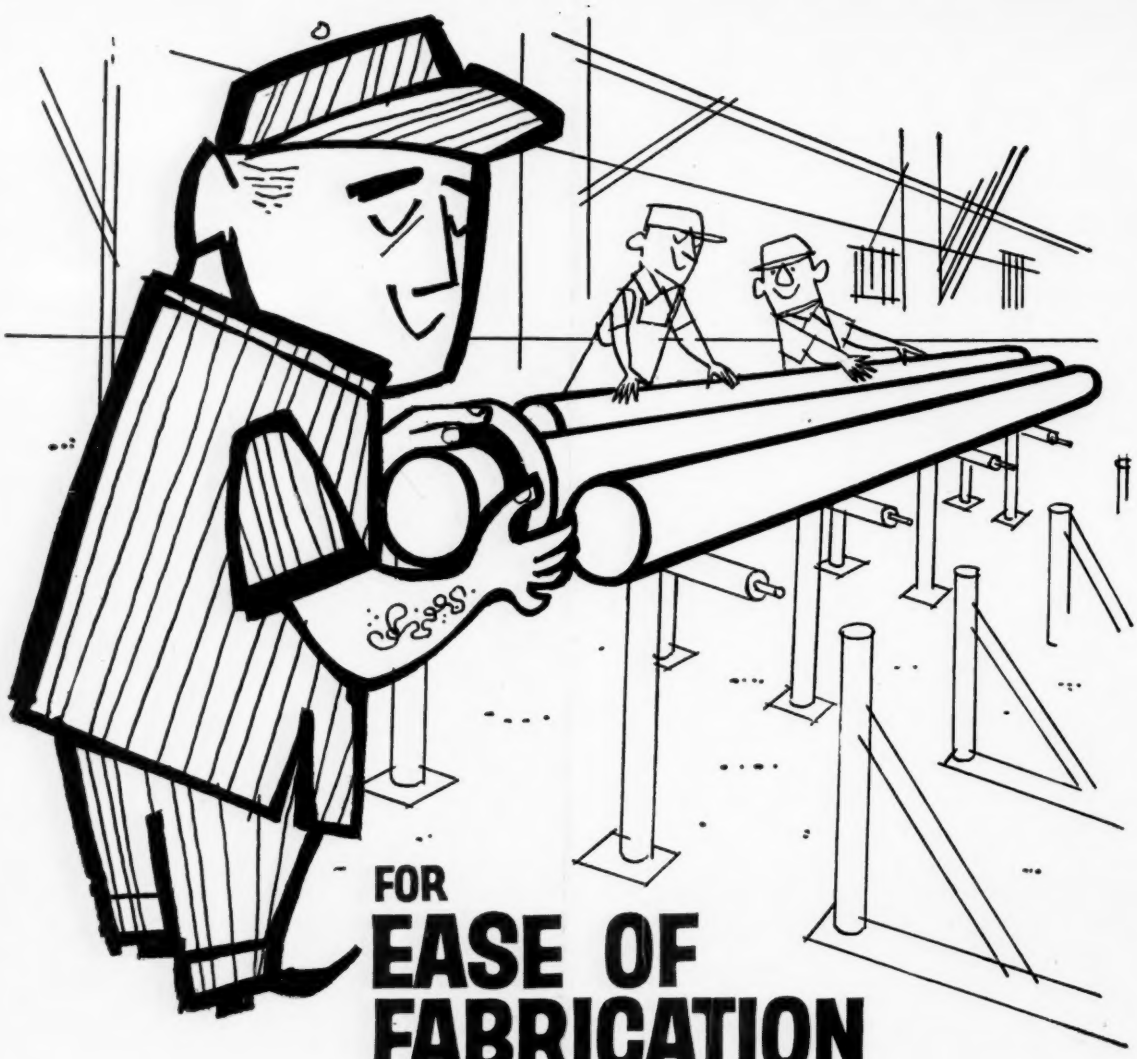
The current overcapacity situation gives Sun a chance to push purity even beyond design levels through use of extensive reflux.



▲ TYPICAL Marcus Hook gas purification plant feeds propylene unit.



▶ POLY unit was sole user of propane-propylene blend; now shares stream with new plant.



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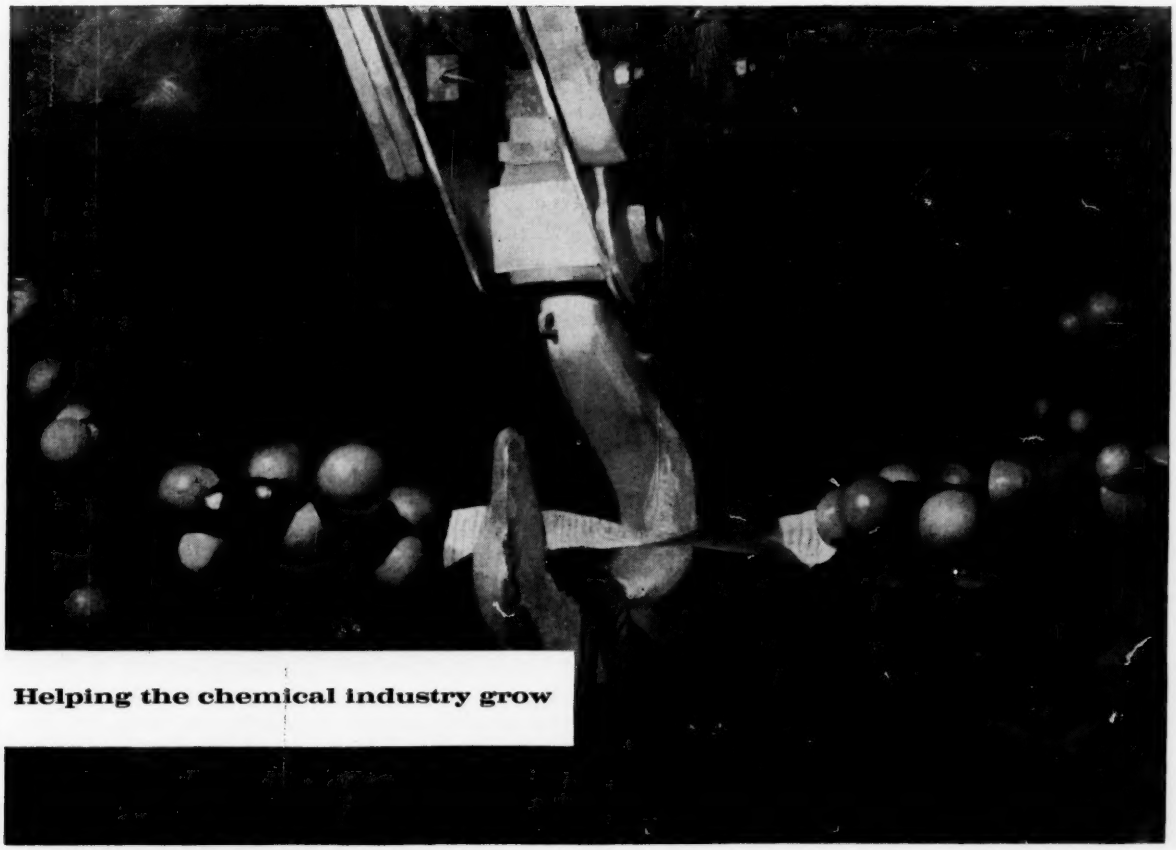

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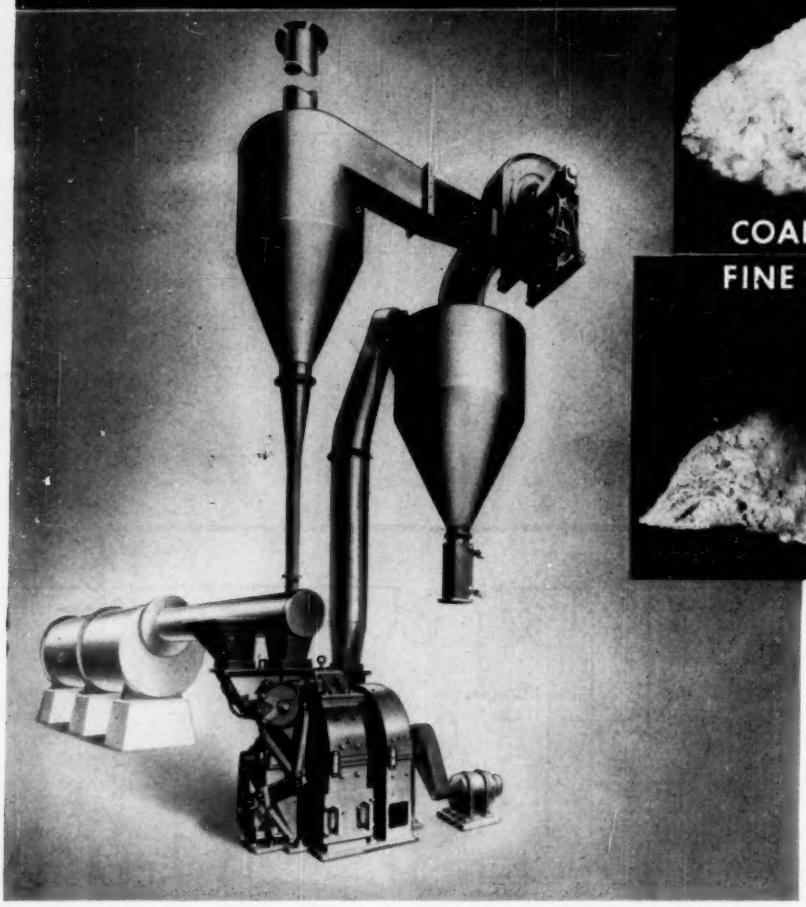

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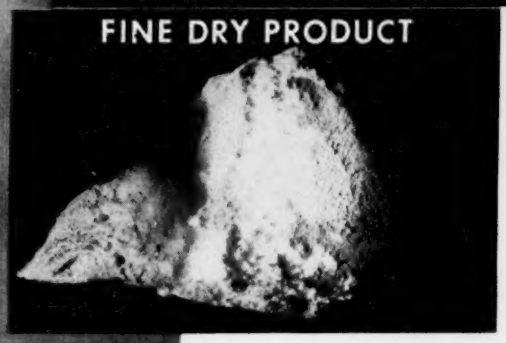

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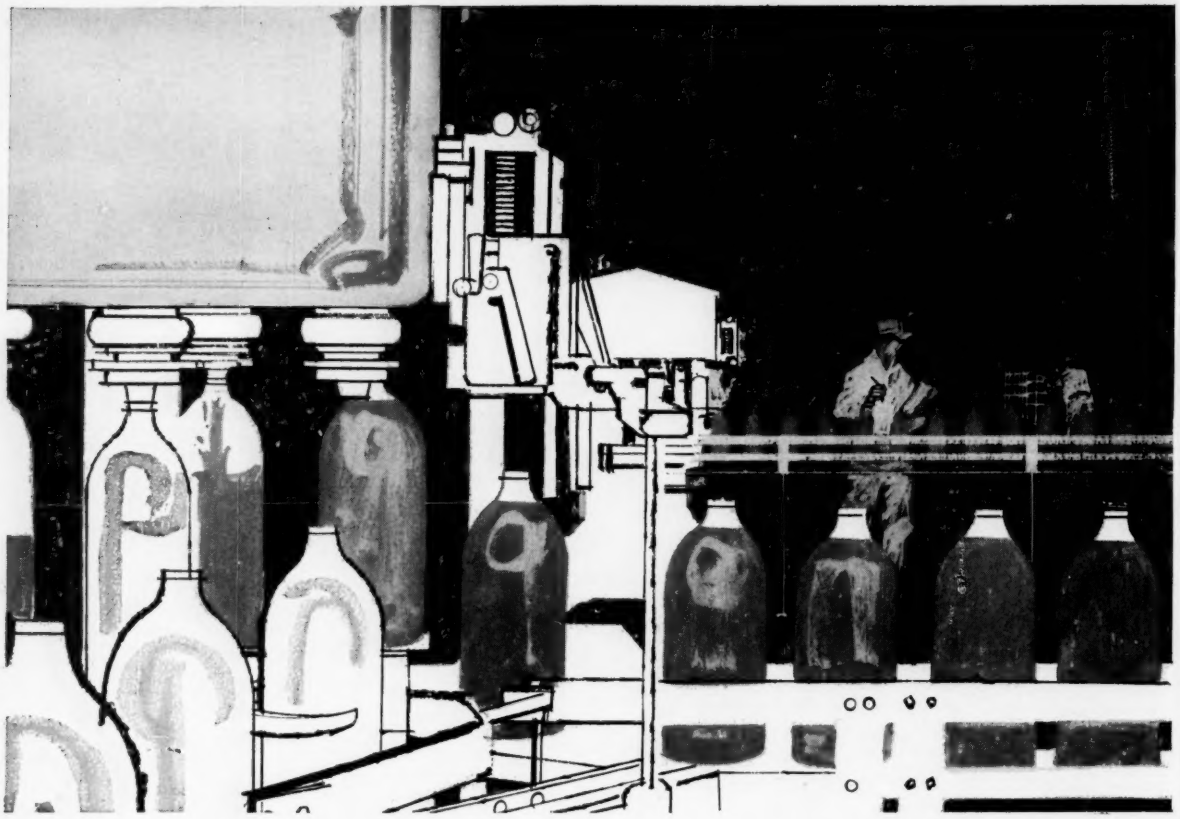

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Chemical Engineering
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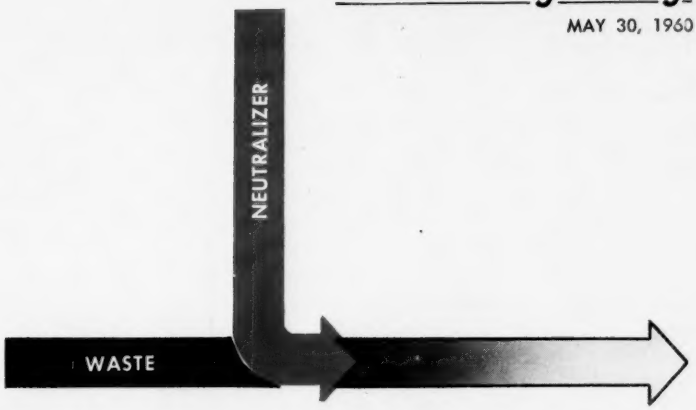


In Waste Treatment . . .

Know Your Chemicals, Save Money

Most waste neutralization in the CPI means selecting an alkali to treat a waste acid. Generally it's true that a high-calcium or dolomitic limestone or lime will be most economical.

H. L. JACOBS, Engineering Dept., E. I. du Pont de Nemours & Co., Wilmington, Del.

Proper conditioning of industrial wastes frequently requires pH adjustment. This is particularly true of wastes from the chemical industry. There are many reasons for neutralizing wastes besides the usual requirement of the control agency involved. If the quantity of acid or alkali is sufficient to affect materially the pH of the receiving stream, neutralization is clearly required. The usually accepted values for streams supporting fish life are pH 5.0 to pH 9.0. Some states have more rigid requirements and the limits should be narrower where game fish such as trout or bass are involved.

It is my opinion, based on experience rather than survey, that the wastes from U. S. industry are predominantly acid in character. I cannot recall an instance in my experience where my own company has had to neutralize an alkaline waste prior to discharge. In a way, this is unforunate since acids are more easily handled than alkalis when used as neutralizing agents. We will defy custom and discuss the minority problem first.

Based on a paper presented before the Industrial Wastes Symposium of the Texas Water & Sewage Works Assn.'s Annual Short School, at Texas A & M College, College Station, Tex. Mar. 3, 1960.

Alkaline Wastes

Alkaline wastes are produced from tanning, paper and pulp manufacture, dye processes, acetylene manufacture and from water softening, to mention a few examples.

When wastes from such processes must be neutralized—and when an acid must be purchased for the purpose—it is usually sulfuric acid which is considered first. It is by far the most plentiful and the cheapest acid for direct neutralization. In the oil industry, we understand, some alkaline wastes are neutralized with carbon dioxide produced by burning oil. It is entirely possible that such a scheme is feasible in the oil industry, but it is not in general application throughout industry. Carbon dioxide is scrubbed from flue gas for this purpose in some cases.

The alkaline wastes from acetylene manufacture and from water softening plants are usually settled in lagoons instead of being neutralized and discharged. These solid alkalis, calcium hydroxide, and calcium and magnesium carbonates, are themselves used as neutralizing agents and will be discussed later.

Other mineral acids such as hydrochloric and nitric can, of course, be used as anti-alkaline agents, but the purchase of such acids for that purpose alone would be unusual because of the cost. Materials of construction for handling these acids are critical and costly. Hydrochloric acid must be handled in Haveg, glass, rubber or some special metal, or plastic. Nitric acid is invariably stored and handled in stainless steel. An exception would be a standard grade of nitric acid containing a substantial quantity of sulfuric acid.

Sulfuric acid may be purchased as 60° Baumé strength, or higher, in tank cars, drums or carboys. The quantity used will determine the method of shipment. The acid

should be diluted in a lead- or rubber-lined tank to a strength of 5 to 10% for feeding to the neutralizing tank. The dilute acid can be introduced to the neutralizing tank by pump or by gravity through standard pH control equipment. The neutralizing tank should have as much retention time (up to 5 min.) as is feasible in order to make the control job easier. If a precipitate is formed during neutralization, special consideration must be given to the method of discharge.

Acid Wastes

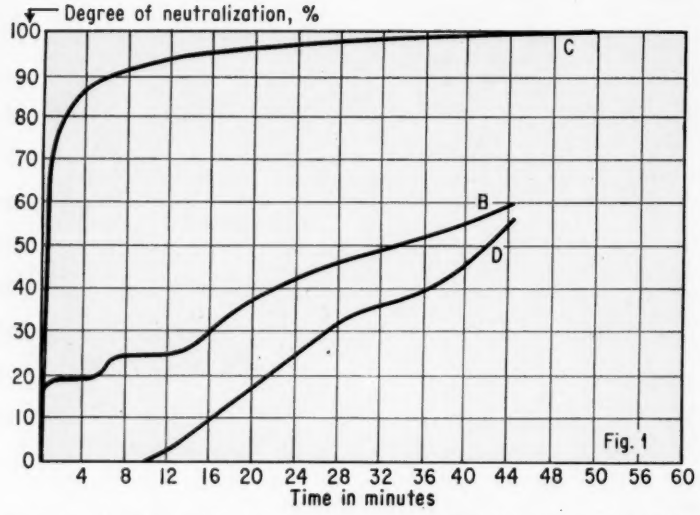
Acidic wastes are produced by steel pickling, pigment manufacture, dye manufacture, chlorination of organics, nitration operations and many others. The largest single waste of this character is probably steel-mill pickle liquor. This waste has potential value in the recovery of iron oxide and sulfuric acid but, to date, the processes for such recovery are uneconomical.

Acid neutralization can be discussed from two points of view: that of the acid which is neutralized or that of the alkali which does the job. The areas of information to be covered are essentially the same in each case. I will discuss the subject from the standpoint of the alkali which may be used.

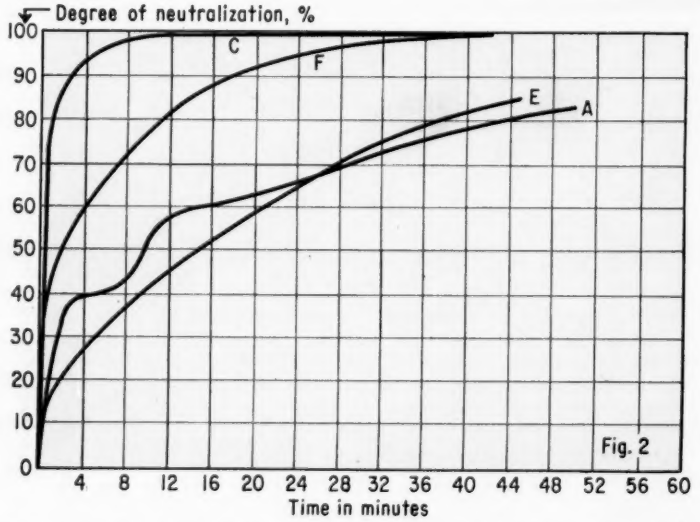
One of the most important aspects of waste acid neutralization is the cost of doing the job. The equipment required and the alkali to be used are the most important factors and these must be kept at a minimum since the cost is an operating expense which must be added to the price of the primary product. No way has yet been found to finance waste disposal without the cost ultimately finding its way to the consumer in the price of what he buys.

When we talk about low-cost alkalis, we are nearly always talking about a calcium-base or a calcium-magnesium-base alkali in one form or another. There may be some situations where another alkali will be available at reasonable cost, but they will be decided exceptions. When other alakalis are available as byproducts, the answer is obvious—use them if at all possible.

Calcium and calcium-magnesium alkalis occur in nature as carbonates in the form of limestones and calcites. Calcium carbonate also occurs in nature as the principal constituent of oyster and clam shells.



Reaction time in neutralizing acid with theoretical limestone; *C* is high-calcium while *B* and *D* contain Mg but are not true dolomites—Fig. 1.



Reaction time in neutralizing acid with 10% excess limestone; stone *C* is high-calcium, while *A*, *E* and *F* are high-magnesium—Fig. 2.

Good grades of limestone will contain 95% or better of carbonates and will be classed as high-calcium stones when magnesium carbonate runs in the neighborhood of 1%. When the carbonates are present in nearly molar ratios (52% $CaCO_3$ and 43% $MgCO_3$), the stone is classed as dolomitic. Analyses will range up and down between those limits, but only the true dolomitic or high-calcium stones are exploited for chemical usage. The in-between stones are usually sold for agricultural purposes.

Two other sources of alkali of excellent quality are available in a few locations—sludge from municipal water softener plants and byproduct calcium carbonate from manufacture of magnesia insulation. These materials are extremely quick acting, perhaps because of a high area-weight ratio of the particles. Another source of byproduct

alkali is the calcium hydroxide sludge resulting from the manufacture of acetylene from calcium carbide. The material is usually produced as a 10% slurry of calcium hydroxide in water.

This slurry is usually pumped to a sludge pond where it accumulates as a rather thick paste of calcium hydroxide. It is an excellent neutralizing agent, particularly if it can be concentrated and hauled away as a slurry before it is put out to dry. Even after it has reposed in a sludge pile for several years, the material below the surface will provide excellent neutralizing ability if the top thoroughly dried material is discarded. The longer the material is exposed to the atmosphere, the more of the surface material reacts with carbon dioxide, thereby losing ability to react with acid rapidly.

In considering the use of alkalis, it will be found that their neutralizing ability and the cost per unit of acid neutralized are relatively unrelated. The table given on p. 92 has been prepared on a rough, comparative basis to indicate the relative cost of the various acids and alkalis at a theoretical location in New Jersey. It must be realized that freight rates are of considerable importance, particularly in the case of the lower cost materials.

As the table shows, the cost of the chemical used for neutralization can vary over wide limits. For any particular situation it will be necessary to take into consideration a great many factors other than delivered costs before a final decision can be made. The material to be used should be selected on the basis of the overall cost rather than the chemical cost alone, since the equipment for utilizing the various forms of alkali will differ with the material selected. With this in mind, I will discuss the advantages and limitations of the materials listed in the tabulation.

High-Calcium Lump Limestone

This material can be used readily in sizes from $\frac{1}{8}$ in. to $1\frac{1}{2}$ in. It is usually quite reactive and will neutralize any mineral acid readily, providing certain requirements are met. Hydrochloric and nitric acids can be neutralized at relatively high concentrations (10-15%) because the reaction products are almost always soluble. Under certain conditions, high-strength acids will foam badly, particularly if some organic matter is present. Naturally, the evolution of CO_2 is greater as the strength of the initial acid increases. Sulfuric acid must be made dilute enough prior to neutralization (0.2-0.3%) in order to prevent the deposition of calcium sulfate on the surface of the stone, thereby inactivating it. With sulfuric acid, the CO_2 evolution is insufficient to cause foaming.

Flow through the limestone bed can be either upward or downward, although the former is preferred. At slow rates, the inert matter will settle out in the false bottom of the tank if one is provided—and it should be. The collected inerts must be flushed out periodically, but will not constitute a problem since they will settle very readily. At high flow rates, the inert matter may stay in suspension and remove itself from the bed continuously. This is a distinct advantage in bed maintenance.

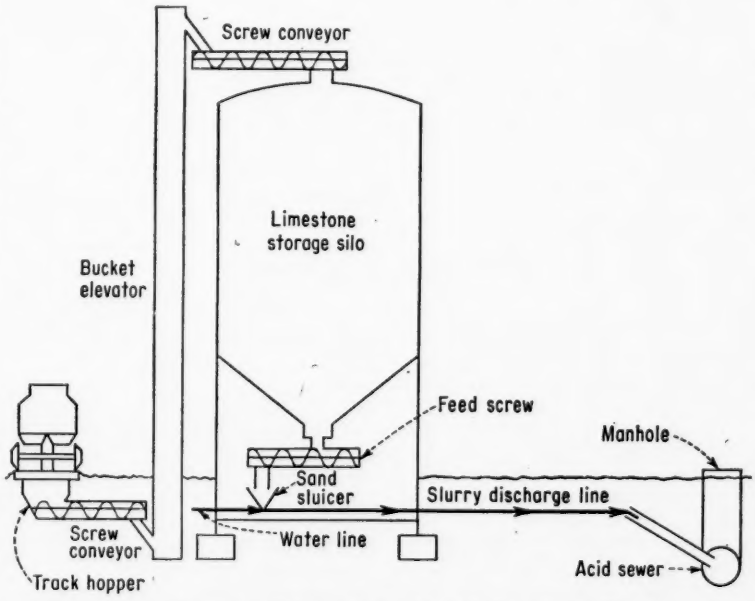
With large lumps ($\frac{3}{4}$ in. to $1\frac{1}{2}$ in.) superficial rates of about 1 gpm./sq. ft. may be obtained with a bed depth of 6-8 ft. With $\frac{1}{8}$-in. to $\frac{1}{4}$-in. stone, rates as high as 60 gpm./sq. ft. may be realized.[1] This high rate is sufficient to expand the bed and to hold the limestone in suspension. The inert matter will overflow from the bed along with the neutralization products.

The main advantage in the use of such beds is the small amount of attention required. If they are designed for maximum flow rates, the wastes will automatically receive adequate treatment at lower rates. No control equipment will be required. The container for these limestone beds can usually be made of wood since dilute acids do not readily attack it. If the tank is round, protecting the bands from leaking seams can be a major problem. Stainless steel bands can be used, of course, but are generally regarded as needlessly expensive. The usual steel bands can be protected by means of plastic covering or by generous applications of asphaltic tars.

Dolomitic Lump Limestone

This material is the cheapest alkali for acid neutralization in areas where it is available without excessive freight costs.

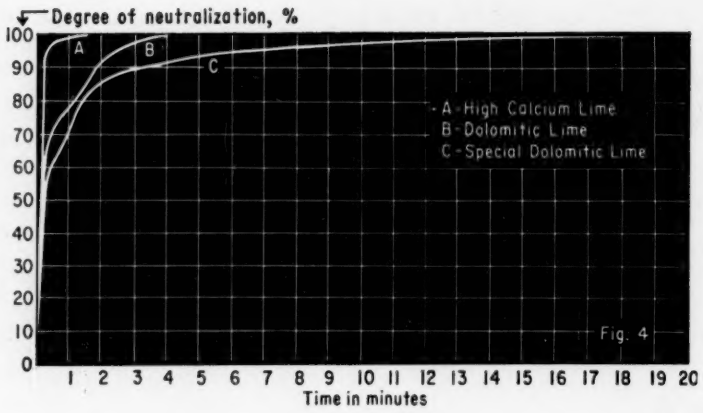
Flow rates will probably be somewhat less than those obtainable with high-calcium stone because the material reacts more slowly. It has 15-16% greater neutralizing value than high-calcium stone and can be used successfully in either up- or down-flow beds. Since the solubility



Equipment setup for neutralizing waste acid with limestone—Fig. 3.

of magnesium sulfate is high, somewhat stronger solutions of sulfuric acid (0.5%) may be neutralized without coating the stone with insoluble calcium sulfate. This can be a distinct advantage in cases where the waste as produced is sufficiently concentrated to require the addition of water for dilution prior to neutralization.

One of the distinct advantages of lump limestone is that no special storage facilities are required. It may be stored on the ground in the open with no ill effects on its usefulness. It can be received in open gondola cars or hopper-bottom cars for unloading to a screw conveyor and elevator. When stored in a pile, the stone may be charged to the beds with conventional equipment such as front-end loaders or bucket cranes.



Reaction time in neutralizing acid with theoretical quantity of hydrated lime; *A* is a high-calcium, *B* a dolomitic and *C* a special dolomitic lime—Fig. 4.

Ground Limestone

Limestone can be ground to various grades of fineness. Air classification will yield stone of great fineness. The finer the grind, the more difficulty will be experienced in handling and feeding. The reaction rate will improve, however, with increased fineness. Stone ground to pass a 20-mesh screen will handle easily in a screw conveyor from silo storage. The time of reaction with theoretical quantities of acid and limestone may require 45-60 min. (See Fig. 1.)

In the graph of Fig. 1, *C* is a high-calcium stone while *B* and *D* contain fair amounts of magnesium although they are not true dolomitic stones. The use of 10% excess stone will easily cut this time in half, as shown in Fig. 2. In this case also, the curves for stones *A*, *E* and *F* show the effects of a high magnesium content. Limestone ground to pass a 200- or 300-mesh screen will have the same handling and feeding characteristics as hydrated lime.

Wastes from a smokeless powder plant have been neutralized successfully with high-calcium limestone of 20-mesh fineness. The sewers were laid out in such a way that a retention time of 30 min. was provided and the inerts and unreacted stone were removed in a settling basin. Unfortunately, automatic pH control is not practical with ground limestone. An ideal situation is one in which only partial neutralization is required so that excess stone need not be fed. Such a system is shown schematically in Fig. 3.

The reaction rate of dolomitic limestone is so slow that its use as a ground material is not considered practical.

Oyster and Clam Shells

Oyster shells can be used in the same manner as limestone. The calcium carbonate content is about the same as that of a good grade of high-calcium limestone. Oyster shells are burned to make quick lime and hydrated lime in certain areas. Price should be the governing factor.

Hydrated Lime

Hydrated lime is usually sold in 50-lb. bags, although a few suppliers can ship it in bulk. Since the handling and disposal of the empty bags is a decided inconvenience, large tonnage usage of hydrate is rather rare. Emptying the bags into the feed hopper is a dusty job, and the handler's wrists and neck must be well protected to prevent burning and chafing. If the material is received in bulk, unloading with a pneumatic conveying system is about the only satisfactory way of getting it out of the cars and into storage.

Hydrated lime can be satisfactorily fed only in equipment designed especially for it. It arches and bridges readily in a storage hopper and must be dislodged by air or by vibration. When thoroughly aerated, the material will flow like water and this can cause serious feeding troubles.

If hydrate is being fed dry, it should pass through a wetting device such as a small tank or mixing chamber so that it may be fed to the neutralizing tank as a slurry. Only in this way will fast reaction with the acid be brought about. The material lends itself to automatic control with readily available controllers and feeders.

High-calcium hydrated lime is a fast reaction alkali. Reaction with dilute acid is usually complete in 0.5 to 1.0 min. The reaction will be more easily controlled if the reaction tank provides several minutes of holdup.

When dolomitic quicklime is hydrated, very little of the magnesium oxide is converted to the hydroxide, usually 2 or 3% of it. I have felt for years that this fact has some connection with the reaction rate of dolomitic hydrate, but I have no real proof. The fact remains that dolomitic lime requires from 4-6 min. to react completely when present in theoretical amounts with the acid. (See Fig. 4.)

Quicklime—General

In the manufacture of quicklime, high-calcium or dolomitic limestone is burned to the oxide by driving off carbon dioxide. Most lime is burned in shaft kilns where the limestone is charged at the top and

removed at the bottom with the hot combustion gases passing upward through it. The limestone is charged in 2-4 in. lumps and is in the kiln about 30 hr. during its travel from top to bottom.[2]

Another way in which lime is produced is by use of a rotary kiln. In this case, 2-in. lump limestone is used. The burning is completed in about 2 hr. as compared to the 30 hr. for the shaft kiln. Because the conditions under which the burning takes place are so different, the physical characteristics of the two materials are not quite alike.

Shaft-kiln lime is traditionally hard-burned and very little unburned carbonate remains in it. As a matter of fact, some overburning occurs, rendering shaft-kiln lime somewhat less reactive than that produced in a rotary kiln. Lime from a rotary kiln is soft-burned and is the most reactive lime available when properly slaked. Due to this soft burning, some of the center particles of the larger lumps are unburned and constitute from 1 to 2% of grit or "core" when slaked. Commercial slakers are equipped for the continuous removal of the "core."

Pebble Lime

In rolling through the rotary kiln, the edges of the limestone particles are rounded off and the screened end product is known as pebble lime. It is an ideal material to handle and is the cheapest form of lime obtainable.

This material is usually sold at the same price or at slightly less than other forms of quicklime. It can be handled in any of the conventional unloading and feeding devices, such as belts, screw conveyors, bucket elevators or vacuum systems. To be utilized to the best advantage for neutralization purposes, pebble lime must be properly slaked.

The slaking temperature for high-calcium quicklime is about 95 C., while dolomitic quick lime will slake at a somewhat lower temperature. The freshly hydrated lime in slurry form is more reactive than the dried product, whether it be of the high calcium or dolomitic variety. This may be caused by a slight degree of carbonation which takes place in producing the dried lime hydrate. In cases where large quantities of acid are to be neutralized, pebble lime warrants serious consideration.

Ground Quicklime

Shaft-kiln lime is sometimes ground through hammer mills before being put into storage bins at the producer's plant. At lime plants where both rotary and shaft kilns are operated, the excess product from the rotary kiln, after pebble requirements are satisfied, is mixed with the shaft-kiln product ahead of the hammer mill. The material is not finely ground and its handling characteristics in conveying equipment are good. It may be somewhat difficult to remove from hopper-bottom cars after being packed down in transit, but it will usually handle easily from subsequent storage.

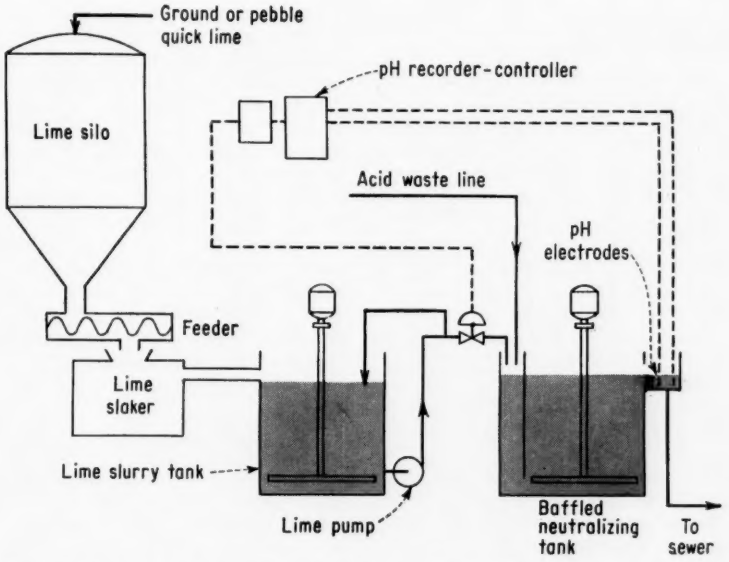
Screw conveyors will handle the material quite readily. Ground quicklime is not so easily slaked as pebble lime, but no difficulty is experienced on this score in properly designed equipment. Less "core" is produced as a rule because the material largely originates in shaft kilns and the hammer mill will break up some of the unburned limestone particles.

Ground quicklime is available in either the high-calcium or dolomitic variety. Quite frequently the freight rate will be a deciding factor since the starting materials, high-calcium and dolomitic limestones, do not usually occur in the same general areas.

Fig. 5 shows a schematic drawing of a plant utilizing ground quick lime or pebble lime for acid neutralization. The lime slurry from the slaker overflows into the lime slurry feed tank from which it is fed to the point of application through a recirculating line. The recirculating line should be designed for a minimum velocity of 5 ft./sec. to prevent the lime from settling out and plugging.

Hercules Powder Co.[3] has operated a neutralization plant at Parlin, N. J., for several years utilizing ground dolomitic quicklime. The lime is hydrated in a Dorr lime slaker and is stored as a slurry just prior to use. The equalization and neutralization are carried out in a five-compartment rectangular tank. The compartments are formed by baffles and each one is agitated. The first two compartments serve as blending or equalizing tanks, with lime slurry being added in the third and fifth compartments.

Slurry addition is controlled by a pH meter at each point of addition. The discharged pH is maintained at 4.0, but additional reaction occurs in the discharge sewer line so



Schematic of plant using ground quick lime or pebble lime for waste acid neutralization—Fig. 5.

Comparison of Chemicals for Waste Neutralization

Alkaline Wastes

Neutralizing Material	Relative Chemical Cost*	Lb. Req'd./100 Lb. Alkali† $CaCO_3$	$Ca(OH)_2$	NaOH
Sulfuric acid (60° Be.)	1.00	126	170	158
Hydrochloric acid (20° Be.)	2.57	232	314	250
Nitric acid (39.5° Be.)	3.51	210	284	263

Acid Wastes

Neutralizing Material	Relative Chemical Cost*	Lb. Req'd./100 Lb. Acid† H_2SO_4	HCl	HNO_3
Lump limestone, high-Ca	1.16	110	148	86
Lump limestone, dolomitic	1.00	94	127	73
Pulv. limestone, high-Ca	1.59	110	148	86
Pulv. limestone, dolomitic	1.37	94	127	73
Hydrated lime, high-Ca	3.06	79	107	62
Hydrated lime, dolomitic	2.50	65	87	51
Pebble lime, high-Ca	2.07	60	80	46
Pebble lime, dolomitic	1.87	54	73	42
Pulv. quicklime, high-Ca	2.18	60	80	46
Pulv. quicklime, dolomitic	1.97	54	73	42
Sodium bicarbonate	20.65	173	233	135
Soda ash	13.08	119	160	93
Caustic soda (50%)	9.96	164	220	127
Ammonia (anhyd.)	5.90	35	47	27
Magnesium oxide	3.90	42	56	33

*Delivered cost including freight. †Commodity weight.

that all mineral acidity has been neutralized before the effluent enters the river.

Sodium Alkalis

While it is possible to use sodium bicarbonate, soda ash and caustic soda for waste neutralization, their use for such a purpose is unusual, at least on a large scale. Unless they are available as waste products, the cost is usually prohibitive. An exception to all this would be a case where the amount of acidity is so small that no feeding or control equipment would be required. Caustic soda or soda ash might be the ideal agent in such instances.

Sodium bicarbonate and soda ash are handled in bags or in bulk in the dry state. The materials are usually shipped in hopper-bottom cars, with unloading through screw conveyors and bucket elevators into storage bins. No particular difficulty is encountered in feeding the material so long as it is kept dry. Anyone interested in seeing how soda ash is handled in bulk should visit a large water-treatment plant where this material is used for pH adjustment prior to coagulation.

If it is at all feasible to use a sodium-base alkali for waste acid neutralization, it will probably turn out that the material is caustic soda. Caustic can be obtained as flake or as 50% solution of NaOH. It is more easily handled in the latter form. The liquid can be received in tank trucks or tank cars and transferred to steel storage tanks. It should be diluted to a strength of 5 or 10% prior to use. The diluted liquid can be pumped or fed by gravity through standard control valves actuated by a pH controller-recorder.

Magnesium Oxide

This alkali is now available in high purity (99% + MgO). It is included here as a neutralizing agent because it is used for this purpose in clarifying uranium ores. The waste waters from the ore plants are acidified with nitric acid and then neutralized with magnesia. A two-fold action is realized since the magnesia also complexes with the uranium and precipitates it. Although I know of no other applications of this material for waste neutralization, it should be kept in mind for special conditions.

In summary, we can state that the most common acid used for neutralization is sulfuric. The alkalis used in nine out of ten cases will be some form of high-calcium or dolomitic limestone—lump, ground, burned or burned and slaked. Other alkalis are of minor importance for this purpose.

And, to conclude, in evaluating a neutralization problem, it is a fundamental principle that all major cost factors should be carefully considered—the cost of the agent, the equipment required to store and use it, the operating labor and supervisory attention required and the ultimate disposal of the reaction products.

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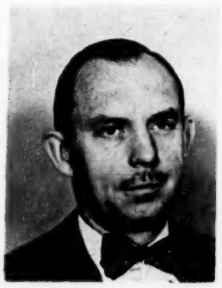


H. L. JACOBS, a chemical engineering graduate of Iowa State, has been with the Du Pont Co. since 1927 in a variety of capacities including research, production and engineering. Since 1938 he has specialized in the field of industrial waste treatment. As a senior consultant, he has represented Du Pont for several years on the Water Pollution Abatement Committee of Manufacturing Chemists Association. He is also a member of the Delaware Water Pollution Commission and is serving his third appointive term on that body.

Consider Hybrid Propulsion Systems

Combining a solid-fuel grain with a liquid oxidizer gives a hybrid rocket having reduced system complexity and increased reliability.

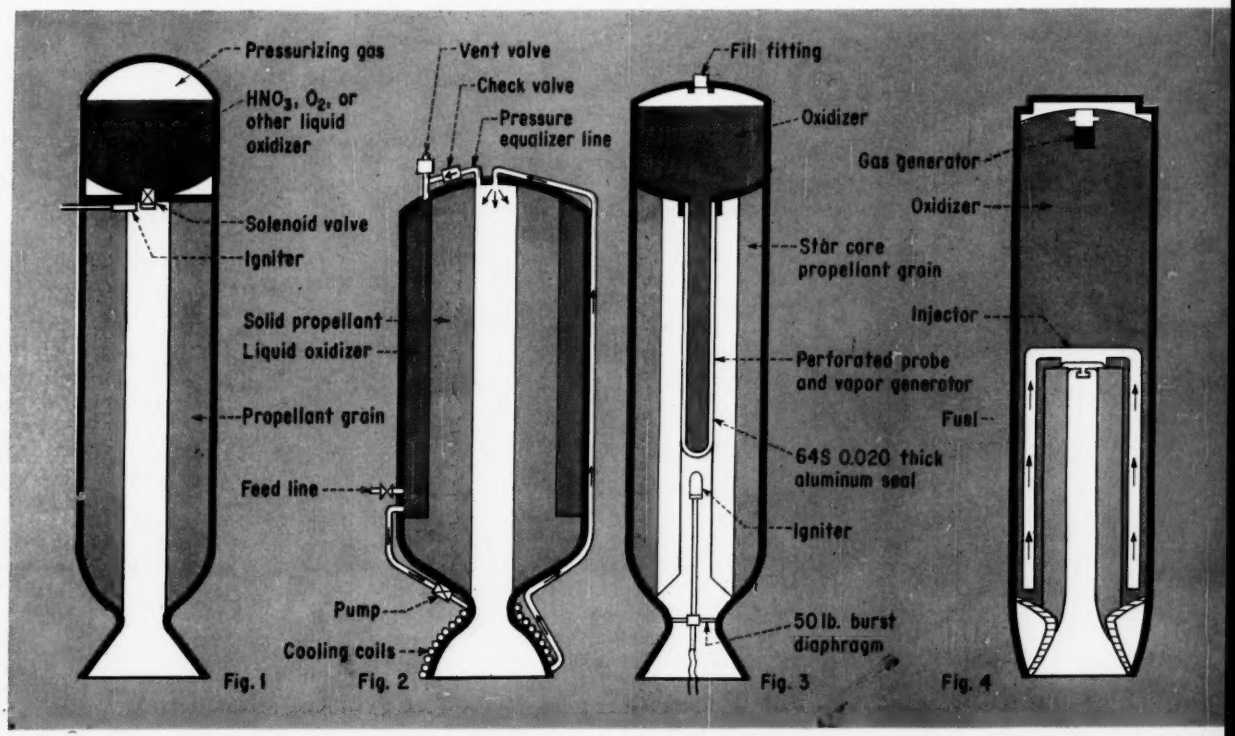
F. J. HENDEL and E. H. CAVECCHE, Aerojet-General Corp., Azusa, Calif.

Limitations of both liquid and solid rocket systems have been studied for many years. Through the normal advancement of the state-of-the-art, a number of these apparent limitations have proved to be surmountable. To overcome what now appear to be inherent restrictions of the conventional systems, the rocket designer has recently turned with renewed interest to the hybrid rocket.

Limited theoretical and experimental studies have already demonstrated that the solid-liquid hybrid rocket possesses or surpasses many of the advantageous characteristics of both solid and liquid systems while retaining few of their deficiencies. This superiority is particularly evident if the restriction of instant readiness and constant volume are imposed. The greater impulse per unit volume possible with the hybrid system will provide maximum incremental velocity gain for any existing first generation missile.

Projected performance of various chemical propulsion systems for a constant volume is shown in Fig. 5. The clustering and overlapping in the central portion of the drawing are primarily due to contemporary system requirements. However, advanced missiles, requiring large velocity gains, will be satisfied by either cryogenic or hybrid propulsion systems.

Hybrid systems can be classified into three basic types: (1) a solid oxidizer grain and liquid fuel, (2) a solid grain containing a portion of the required oxidizer with the balance in a liquid phase and (3) a



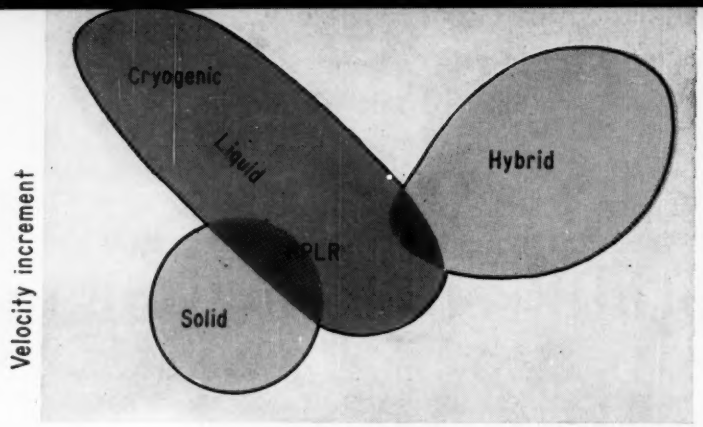


Fig. 5

PPLR=Pre-packaged liquid rocket

solid fuel grain with liquid oxidizer.

The first type presents a number of difficulties and limitations with currently available fuels and oxidizers. It remains an interesting area for future development. The second type represents a method of improving the physical properties of a composite solid propellant by reducing the oxidizer loading. At the same time, marked performance increase in the propulsion system is also possible through provision of a supplemental high energy liquid oxidizer. The reduction of solid oxidizer can be so great as to exclude it altogether. This leads to the third type which is dependent upon the liquid oxidizer to sustain burning.

A convenient method of comparing the hybrid system with its competitors is on the basis of design, fabrication, operation and logistics.

Design and Fabrication

The hybrid rocket provides greater flexibility in design, but with a slight sacrifice in simplicity when compared with a solid-fuel rocket. By reducing the solid oxidizer loading, the hybrid eliminates many of the difficulties involved in the preparation of a high-performance grain which is required to have good physical properties over an extreme temperature range.

Vibration, shock sensitivity and thermal cycling are improved. Propellant mixing is safer and easier. Where all of the solid oxidizer is eliminated, grain manufacture is less costly in time and facilities.

Compared with the bipropellant liquid rocket, the hybrid system provides at least the same degree of design freedom but with reduced system complexity and increased reliability. Development time and costs should be appreciably less once the detailed characteristics of hybrid systems are better known.

How the Hybrid Performs

A hybrid system will allow higher acceleration loadings involved in rapid maneuvering and greater operational flexibility than a solid rocket. Also, intermittent operation is possible by means of hypergolic solid-liquid combinations or by maintaining low-level solid combustion between oxidizer injections. Such operations can be internally or remotely controlled. Thrust can be varied over a wide range by control of oxidizer flow. Use of increased firing durations in conjunction with variable thrust is further enhanced by use of a liquid-oxidizer regeneratively-cooled nozzle.

The hybrid system has the advantage of obtaining closer mixture ratio control than that of a liquid system because only the oxidizer flow need be controlled. Thus, better utilization of the stored energy and maximum system performance results. Also, the hybrid engine can eliminate hard or explosive starts by providing an extensive solid surface for hypergolic ignition.

Logistics of Hybrid Rockets

Hybrid systems wil be less susceptible to malfunction due to hidden defects that occur during or after manufacturing when compared to a solid rocket. Further, by separating the oxidizer and fuel in the rocket, there is less hazard due to ignition or detonation. For the ultimate in safety, the liquid oxidizer may be removed completely from the rocket for long term storage and refilled at any time prior to shipment for use.

Hence, the hybrid system is far superior, logistically, to the cryogenic liquid system. A hybrid system has the same characteristics of storage, handling and instant readiness for firing as the prepackaged liquid rocket.

Examine System Schematics

A few possible arrangements of the hybrid rocket propulsion system which are readily adaptable to missile application are presented along with a brief description of each.

An arrangement for a gas-pressurized oxidizer is shown in Fig. 1. The tank with the liquid oxidizer is located in the forward section of the propulsion unit using the fore-end closure of the chamber as part of the tank. The liquid is pushed into the perforation (core volume) of the solid grain, either by stored gas or by gas from a gas generator. Ignition may be by an igniter as shown in the figure, by a hypergolic slug contained between two burst diaphragms or preferably by the use of a hypergolic oxidizer.

A configuration in which the tank containing liquid oxidizer is located around the rocket chamber in the form of an annulus is shown in Fig. 2. Liquid is delivered into the fore end of the grain perforation by a pump or other means. The liquid oxidizer provides cooling for the grain and nozzle during firing.

A self-pressurizing engine is shown in Fig. 3. This engine functions as follows: heat from the burning propellant grain removes a thin shield from the probe-type injector and heats the oxidizer to a vapor pressure higher than the combustion chamber pressure. The acceleration head of the missile along with the percolator principle can be used to pump the fluid.

The configuration for a minimum tail-off hybrid is shown in Fig. 4. The normal tail-off area of the solid grain consists of hollow tubes connected to the main oxidizer tank through the rear oxidizer tank closure. A cross section through the chamber is shown in Fig. 6 and illustrates the relation of the hollow tubes to the solid grain.

A small siphon will carry the liquid oxidizer from the rear of each tube to the oxidizer injector. Using one siphon for each of the oxidizer tubes, the propellant outage is kept to a minimum because of the large length to diameter

ratio of each tube. Minimum outage insures that maximum use is made of the available energy and that the burnout weight is at a minimum. Since there is no thrust tail-off, the performance of the system is kept at a maximum through the entire time of burning.

Experimental Program

A series of tests were conducted at our Sacramento facilities in an effort to provide experimental data to substantiate previous theoretical and analytical analyses of a hybrid system. The test results were to provide numerical values which could be used in the actual design analysis for propulsion units.

Secondary results, also sought, would provide basic information on the approach to system problems such as ignition, stability, pressurization, reliability, safety, thrust termination and decay, burning characteristics and sensitivity to mixture ratio.

To establish the merits of the hybrid system, two different solid propellant compositions were cast with three different core configurations. The grains were case-bonded with an internal-star port. The test program was intended to obtain the maximum information possible from the limited number of firings. To accomplish this, different liquid oxidizers were used, flow rates were varied, and three types of injectors provided various flow patterns and liquid droplet sizes.

Solid-Grain Composition

Our propellants frequently contain over 75% of total solid loading with the balance a polyurethane polymer which acts as a binder for solid particles and also as fuel. The total solid loading consists of a mixture of ground solid oxidizer, ground metallic solid fuel and fractional percents of solid additives such as compounds for increasing the burning rate and polymerization catalysts.

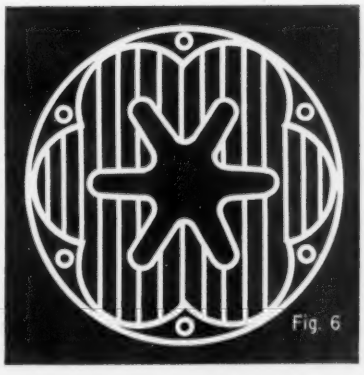


Fig. 6

Injector Selection

The solid grain formulation used in the feasibility study did support combustion but was also definitely fuel-rich. The injector had to provide a pattern and droplet size that would allow uniform mixing of the liquid oxidizer with the combustion gas of the solid grain. The problem was further complicated because the velocity of the combustion gas varied as the grain port area increased with burning duration.

After extensive investigation, the best methods to accomplish these objectives were determined. The methods are either to introduce a low velocity fog into the chamber and allow the combustion gas of the solid to move the oxidizer on demand, or to project a perforated tube into the center of the core and approximately two-thirds the length of the core which would produce fluid at various sections along the grain.

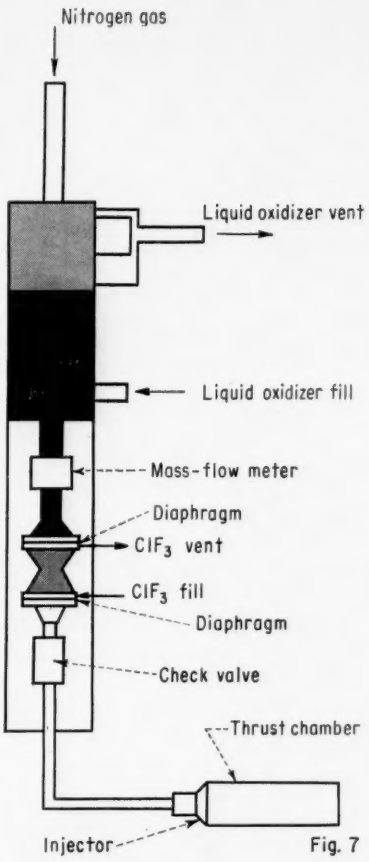


Fig. 7

Method of Ignition

Since a hypergolic oxidizer was not used for the test firings, a method of igniting the grain was incorporated into the system. The original test set-up using a hypergolic slug contained between two burst diaphragms is shown in Fig. 7. At fire switch, the oxidizer tank was pressurized, rupturing the burst diaphrams and allowing the slug to enter the chamber where autoignition occurred. Later tests were conducted using an igniter inserted through the throat and an oxidizer valve upstream of the injector. Both the igniter and valve were initiated simultaneously at fire switch.

Compare Test Results

Experimental average standard specific impulse, as shown in Fig. 8, for the solid grain before the addition of liquid oxidizer is 225 sec. With the injection of 18 to 19% by weight of liquid N_2O_4 oxidizer, the maximum specific impulse is 246 sec. Maximum theoretical standard specific impulse at the same condition is 267 sec. which gives an over-all efficiency for this hybrid propellant combination of 92.2%.

Using liquid ClO_3F as another oxidizer gives results which parallel those shown in Fig. 8. As shown in Fig. 9, a mixture ratio of 22 to 24% by weight ClO_3F results in a maximum experimental standard specific impulse of 246 sec. Therefore, the over-all efficiency using this hybrid propellant commination is 91.8%.

Thrust and pressure-time curve, typical of the hybrid feasibility results, is given in Fig. 10. This test used a standard igniter inserted through the throat of the rocket. The first peak in the curve indicates the method of ignition. Oxidizer was allowed to flow for about 3 sec. at which time fire switch was initi-

ated to close the oxidizer valve. This allowed the grain to burn as a hybrid and as a solid rocket, providing an indication of the increase in performance when the oxidizer was added.

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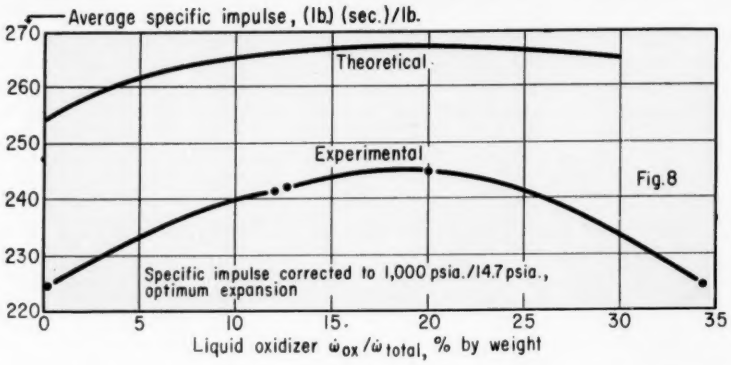
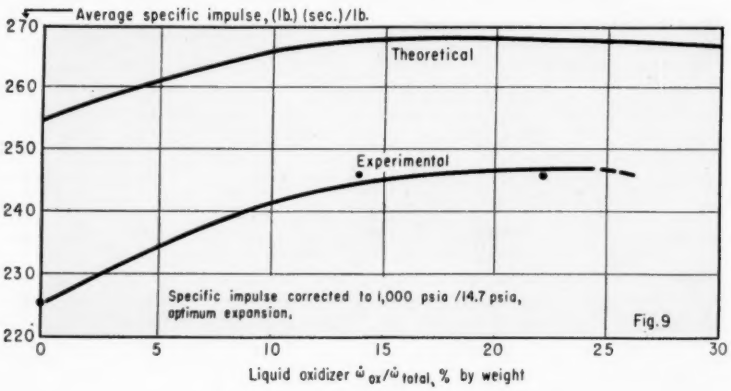
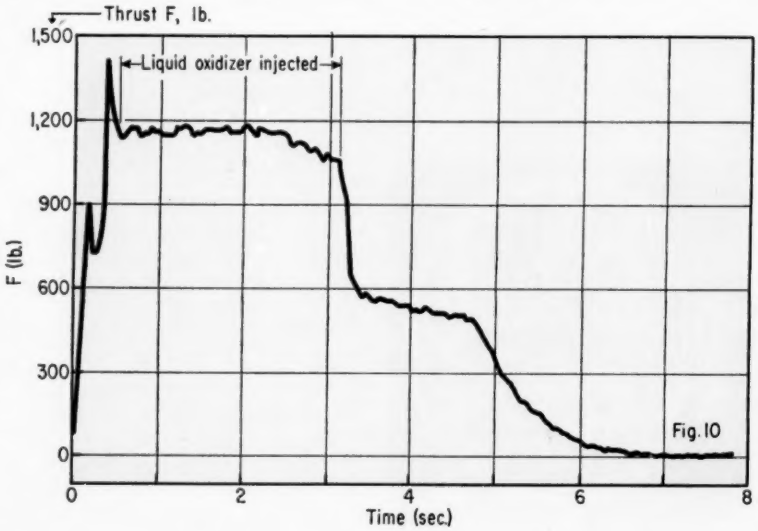
Examine Performance of Hybrid System With Liquid N_2O_4

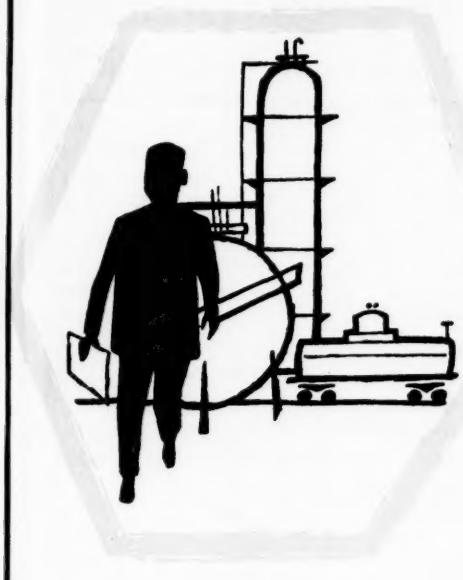


Compare Performance of System Using Liquid ClO_3F



Liquid Oxidizer Increases Thrust in Hybrid Rocket





Systems Engineering, Part 5

Process Plant Design

A combination of systems engineering and process design produces a plant flowsheet for manufacture of product P.

THEODORE J. WILLIAMS, Monsanto Chemical Co., St. Louis, Mo.

In the process example considered in this series on systems engineering in the CPI,* we've designed only for an over-all optimum plant scheme. We used computers to attain this optimum, but the design has been no different than what *might* have been obtained by hand with traditional design-for-steady-state methods. By using computers, we have had time to try many design parameters to find the best over-all plant to meet external steady-state requirements.

No attempt, however, was made to achieve optimum unit equipment design or to design for changing plant operation conditions. Normally we should consider the latter, if known, at this time; their effects could greatly alter final design. In this series, we'll take up this design aspect later, because the systems group has just received the following memo from the project engineer:

MEMO

TO: Systems Engineering Group
FROM: Joe X. Smirk

I'll admit you've helped a lot with this plant to manufacture P. Particularly you've given us an unusual picture of process kinetics, you eliminated the need for a pilot plant and you came up with an optimum over-all plant in about the time that we could have gotten one designed by hand. However, we're already cutting into the construction season, so I'd like to halt your work and get the show on the road. I'm beefing up my design crew here to complete the work based on what you've done so far. Thanks for your help, and by the way, would any of you fellas like to work at a board with us?

Using probable flows and conditions already determined by preliminary calculations of return on investment, we can now proceed with the details of plant design. The tables on the next page carry process design specifications for each equipment unit in the proposed plant. And a flowsheet of the completed plant design appears on pp. 100-101.

Design for Unit Operations

We have, in earlier chapters, discussed the development of process kinetics and best reaction conditions by computer. Following economic optimization of the over-all plant, design details of the stirred-tank reactor shown in Table I were developed by the process design section. Reactor, as well as other equipment units in the process, is shown in its relationship to the whole plant in the flowsheet on pp. 100-101.

To avoid overproduction of the waste material, heavy oil *G*, and consequent reduction in product *P*, the reaction mixture must be cooled until it essentially stops the reaction. Too, *G* becomes insoluble in reaction mixture when temperature is less than 100 F. Reaction cooler-exchanger, specified in Table V, will reduce reaction mixture temperature to 100 F. or below to satisfy both requirements.

Since waste material *G* is insoluble at stream tem-

* Based on the 1959 Schoch Lecture at the University of Texas, the series has appeared in *Chemical Engineering*, Feb. 8, 1960, pp. 121-6, Mar. 7, 1960, pp. 131-6, Apr. 4, 1960, pp. 139-44, May 2, 1960, pp. 121-6.

Distillation Column Design–Table II

Number of bubble-cap trays	20
Feed plate is fifth plate from bottom	
Plate spacing	2 ft.
Vapor velocity	4.5 ft./sec.
Plate diameter	10 ft.
Weir length	6 ft.
Weir head	1.65 in.
Bubble caps (151 caps/tray)	
Diameter of caps	6 in.
Equilateral spacing of caps	9 in.
Skirt clearance	1.75 in.
Rectangular slots, width	0.25 in.
depth	1.25 in.
Liquid seal	2 in.
Pressure drop/tray	4 mm. Hg
Still pot pressure	350 mm. Hg
Condenser pressure	270 mm. Hg.
Condensate temperature	89 F.
Downcomer area	2.5 sq.ft.
Holdup/tray	1,182 lb.
Material of construction is steel	

Overhead Condenser Design–Table III

Shell side of exchanger	
Diameter	39 in.
Length	20 ft.
Baffle spacing	3 ft.
Baffle cut	45%
Pressure drop	28 mm. Hg
Overhead flow rate	92,249 lb./hr.
Inlet temperature	94 F.
Outlet temperature	89 F.
U	150 Btu./(sq.ft.) (hr.) (°F.)
Shell side is split-feed	
Tube side of exchanger	
Number of tubes	1,258
Number of tube passes	4
Tube outside diameter	0.75 in.
Gage	14 BWG
Pitch (triangular)	15/16 in.
Flow rate	356,000 lb./hr.
Coolant (water) temperature, avg.	60 F.
max.	75 F.
Material of construction is steel	

Reactor Design–Table I

Effective liquid volume	4,640 lb.
	92.8 cu.ft.
Excess heat produced in reaction	
Gross materials formed	18,540 lb./hr. C
	15,007 lb./hr. E
	7,501 lb./hr. P
	3,721 lb./hr. G
Heat of reaction	3,973,616 Btu./hr.
Heat required to produce reaction temperature	3,644,952 Btu./hr.
Excess heat	328,664 Btu./hr.
Cooling coils installed	
382 ft. of 1 in. copper, 18 BWG	
1.7 cu.ft. is effective coolant volume	
U = 50 Btu./(sq.ft.) (hr.) (°F.)	
Effective area is 100 sq.ft.	
Heating coils installed	
382 ft. of 1 in. copper, 18 BWG	
1.7 cu.ft. is effective heating fluid volume	
U = 100 Btu./(sq.ft.) (hr.) (°F.)	
Effective area is 100 sq.ft.	
Reactor operating pressure	3 atm.
Material of construction is steel	
Since reactor is well-insulated, heat loss is negligible.	

peratures of 100 F. or below and has a much higher specific gravity than the carrier stream, it can be removed by settling. A steel decanting vessel separates *G*. Its effective liquid volume of 185 cu.ft. (of which 140 cu.ft. is column feed layer, 45 cu.ft. is *G*) allows an average residence time of 5.8 min.—sufficient to get the required separation.

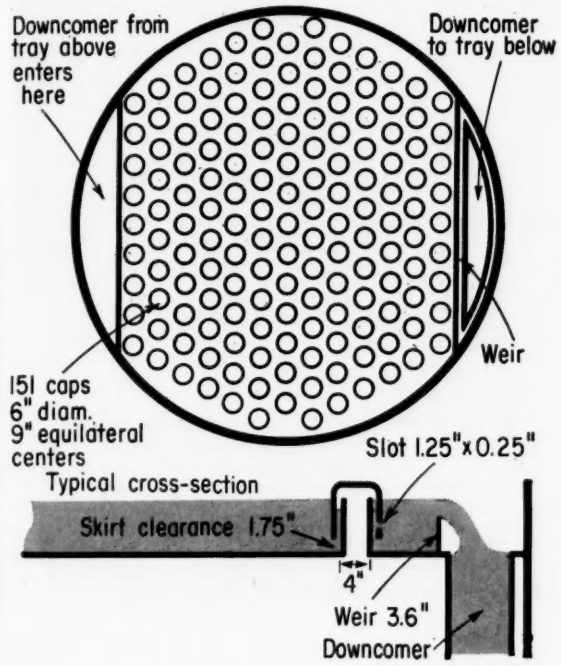
Should temperature of material in the decanter rise above that temperature at which *G* becomes insoluble, the interface between column feed material and *G* will disappear; *G* will mix throughout the total volume. If this happens, column feed material will be discharged in waste stream with *G*, and *G* will be included in column feed, eventually to return to reactor in recycle. Under improper temperature control, *G* can build up in all streams except column overhead.

Effluent stream from the decanter carries *P* to the distillation column where it is separated as overhead. Bottoms from the column split for recycle and for discard. Discard stream, regulated as a certain fraction of column bottoms flow, carries residual value as byproduct. Recycle stream takes all excess back to the reactor. Table II shows column design details. Tray layout for the column trays is shown in Fig. 1.

As shown in Fig. 9, Part 2 of this series, product *P* forms a high-boiling azeotrope with intermediate byproduct *E*. Therefore, column bottoms stream (and recycle and discard streams) carries some *P*.

Designing condenser and reboiler for column balances and external conditions results in specifications

Column Tray Layout–Fig. 1



Column Reboiler Design–Table IV

Shell side of exchanger	
Diameter	40 in.
Length	12 ft.
Baffle spacing	20 in.
Baffle cut	25%
Heating medium (water) flow rate	437,500 lb./hr.
Sparge steam added	8,780 lb./hr.
Mean temperature gradient	31 F.
$h_{outside}$	700 Btu./(sq.ft.) (hr.) (°F.)
Fouling factor, R_D	0.003 (sq.ft.) (hr.) (°F.)/Btu.
Tube side of exchanger	
Number of tubes	1,176
Number of tube passes	2
Tube outside diameter	0.75 in.
Gage	14 BWG
Pitch (triangular)	1 in.
Bottoms flow rate	462,000 lb./hr.
Pressure drop	111 mm. Hg
h_{inside}	260 Btu./(sq.ft.) (hr.) (°F.)
Holdup (exchanger & sump)	10,080 lb.
Material of construction is steel	

of Table III and IV. In operation, heated liquid from the reboiler is to be flashed at reduced pressure to provide vapor flow at 121 F. to column. Amount of total return flow vaporized is 20%.

Optimizing Unit Design

We've seen that computers, particularly large-scale digital computers, permit practical direct computation of economically optimum over-all plant design. Although our project engineer has rejected them, computers are also valuable in detailed unit design.

One of the first uses of digital computers in chemical engineering studies was distillation column design.[1, 2, 3] In the decade that has followed, continued study of machine computation methods accompanied by better machine capabilities has produced programs to completely describe optimum column design for many liquid mixtures[4] and carry out major part of design for others.[5, 6]

Analog computers also have been used for column design,[7] but they do not have flexibility of the digital machines and are not recommended for this task.

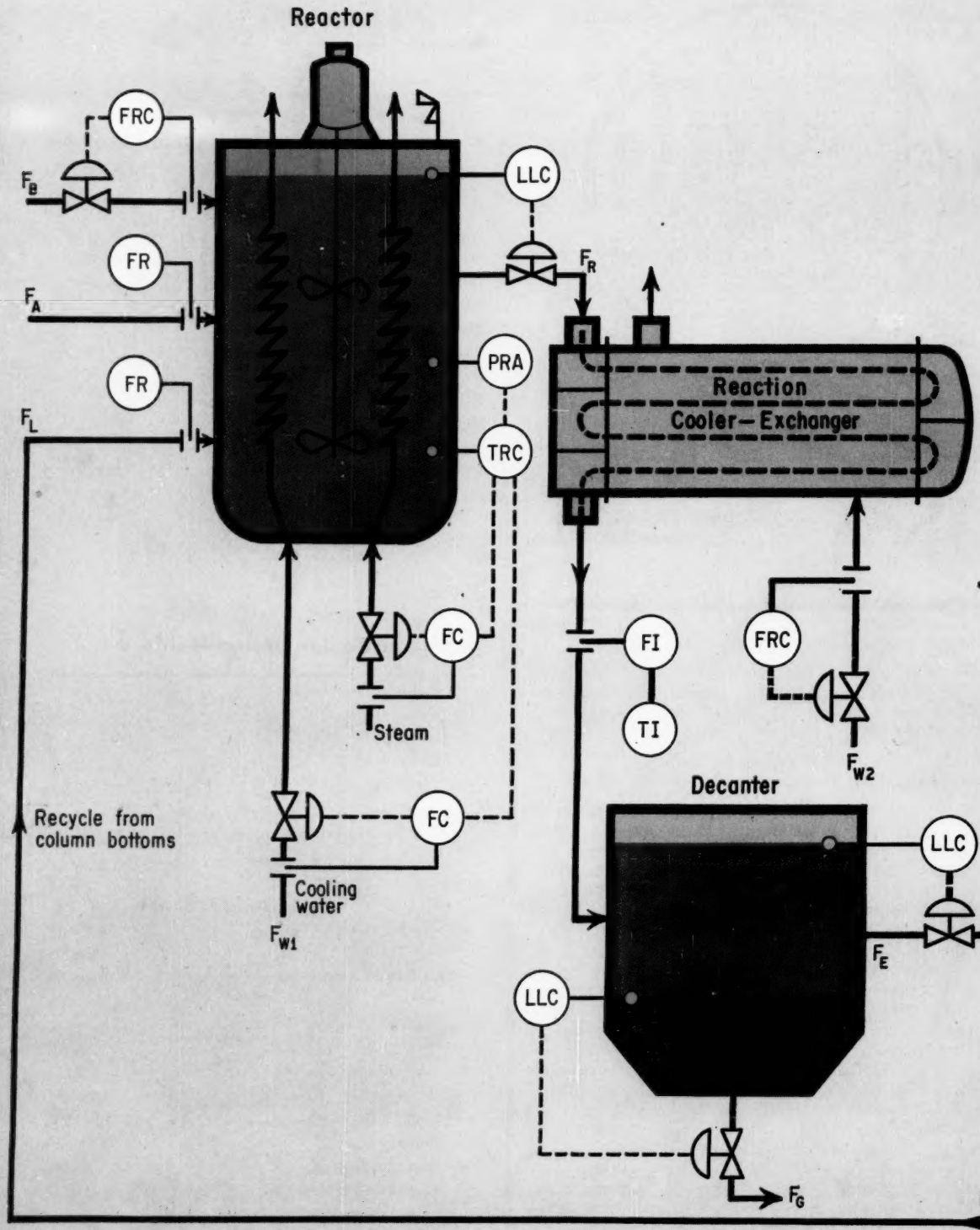
Both analog and digital machines have been set up for heat exchanger and condenser design.[5, 6] As shown in Part 3 of the series, chemical reactors are well-handled by analog computers. Dynamic aspects of reactor operation are more important in design than for any other piece of processing apparatus.[5, 6]

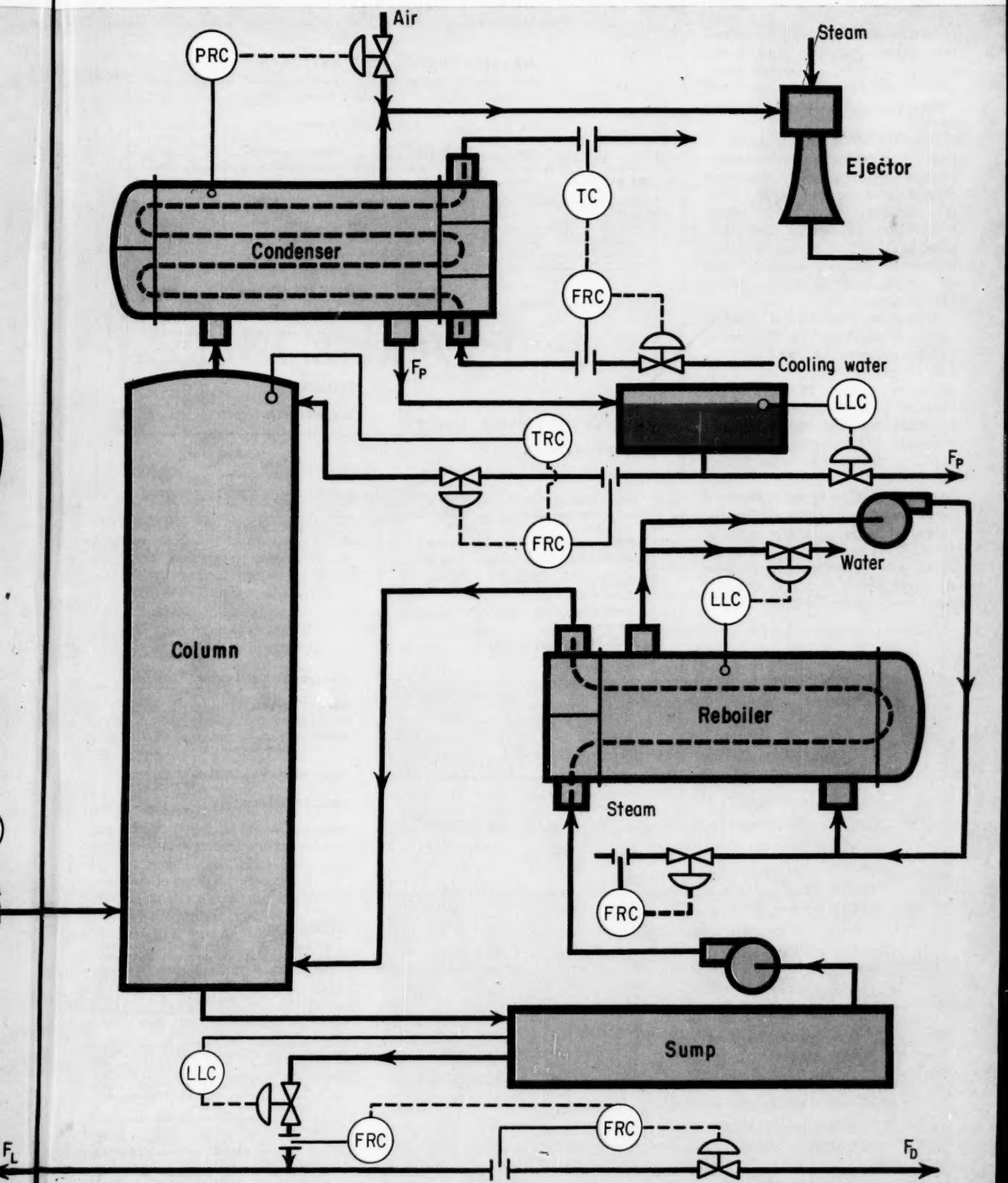
Programs have been developed to carry out design

Reaction Cooler Design–Table V

Shell side of exchanger	
Diameter	16 in.
Length	16 ft.
Baffle spacing	16 in.
Baffle cut	35%
Pressure drop	2.2 psi.
Coolant (water) flow rate	153,500 lb./hr.
Inlet temperature	60 F.
Outlet temperature	80 F.
U	125 Btu./(sq.ft.)(hr.)(°F.)
Coolant volume, V_{HS}	13.3 cu.ft.
	830 lb.
Tube side of exchanger	
Area	569 sq.ft.
Number of tubes	184
Number of tube passes	4
Tube outside diameter	0.75 in.
Gage	14 BWG
Pitch (triangular)	15/16 in.
Velocity	4.4 ft./sec.
Pressure drop	7.4 psi.
Tube-side volume, V_{HT}	274 lb.
Material of construction is steel	

Here is the Project Engineer's Plant Design–Fig. 2




Air
PRC
Steam
Ejector
TC
Condenser
FRC
Cooling water
F_P
LLC
TRC
F_P
FRC
Water
LLC
Column
Reboiler
Steam
FRC
Sump
LLC
FRC
FRC
F_L
F_D

of structural members, to calculate piping stresses and make piping layouts.[8] Digital computers can be used to do most computations necessary for any design.

Finding optimum design for a particular equipment unit nearly always involves trial design of almost innumerable cases. This is particularly difficult when completion of design for each case is itself a repeated trial-and-error procedure, each trial of which has several hundred calculations.

However, when hand computation is used only a few cases can be investigated, and exigencies of project completion—such as have arisen in our hypothetical case—require numerous shortcut formulas and handbook methods. Attainment of anything close to optimum process design would be fortuitous. By allowing computation of an extremely large number of cases in the interval of time normally used to investigate only a few cases by hand, use of computers assures a design much closer to optimal than ever before possible.

MANUFACTURING COST ESTIMATE

MFG. CAPITAL:	M & E		Product	P
	Bldg.		Process	
	Total	1,035,000	Annual Production	

RAW MATERIAL

Material	Unit	Quantity	$/Unit	$/Year
A	M #	121,800	20	2,436,000
B	M #	280,000	30	8,400,000
			GROSS RAW MATERIAL COST	10,836,000
By-Product (Credit)				
			TOTAL CREDIT	
			NET RAW MATERIAL COST	

DIRECT EXPENSE

Steam	M Lbs.	84,000	1.00	84,000
	M Lbs.			
Water – Plant	M Gal.	500,000	0.25	125,000
Sanitary	M Gal.			
Electricity	KWH	330,000	0.01	3,300
Fuel				
Waste Disposal				311,700
Supervision				10,000
Labor				50,000
Payroll Charges				6,000
Repairs				50,000
Laboratory				50,000
			TOTAL DIRECT CONVERSION	690,000
			INDIRECT EXPENSE	
			Depreciation	104,000
			Factory Indirect Expense	6,000
			TOTAL INDIRECT CONVERSION	110,000
			TOTAL CONVERSION	800,000
			TOTAL MANUFACTURING COST	11,636,000

Over-all Profitability Estimate–Table VI

Manufacturing capital	
Total principal items	$ 382,000
Installed, with all accessories	1,035,000
Nonmanufacturing capital	
Steam, 10,000 lb./hr.	200,000
Electric power, 50 kw.	5,000
Others, 1% of mfg. cost	116,000
Working capital (10% of sales)	1,424,000
Total capital	2,780,000
Annual net sales	
40 million lb. of P at 30¢/lb.	12,000,000
330 million lb. of D at 0.68¢/lb.	2,236,000
Gross sales	14,236,000
Annual manufacturing costs	11,636,000
SARE expense, 12.4% of sales	1,761,000
Net profit, before taxes	839,000
Return, before taxes	30.2%

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Special Carbon Steels

Tough and Ductile at Subzero Temperatures

R. W. VANDERBECK, U. S. Steel Corp., Monroeville, Pa.

Low temperature plays many perverse tricks on materials. Most chemical engineers remember the rubber-ball-that-shatters routine which is a favorite demonstration of many college chemistry professors. But low-temperature technology has gone far beyond the rubber-ball stage in the last few years.

Many chemical engineers will come up against a low-temperature problem at some time in the future, particularly as the technology, spurred by our rocket program, becomes more practical and economical.

With this thought in mind, we introduce this series on low-temperature materials of construction. For low-temperature containment must keep up with process technology, particularly as the techniques go further down the temperature scale. Fortunately, a number of alloys are available with excellent subzero properties. But each has certain disadvantages. This article, and the articles which follow, will delineate benefits and shortcomings. Future treatments will discuss alloy steels, stainless steels, nickel alloys, aluminum, copper, and a critique from a major designer of low-temperature process plants.

Special carbon steels are often required for low-temperature applications because of one unfavorable effect that low temperature has on material behavior: markedly reduced ductility in the presence of a notch or similar stress-raiser.

In general, low temperature has a favorable effect upon other mechanical properties. For example, hardness, yield strength, tensile strength, and fatigue strength increase as temperature decreases. The increase is slight in the temperature range of interest for carbon steels (down to about −50 F.). But the decrease in ductility in this range is important enough to warrant special considerations and to require steels developed for operating at lower temperatures.

Some of the more important uses for these tougher grades of steel are pressure vessels, ships, storage tanks.

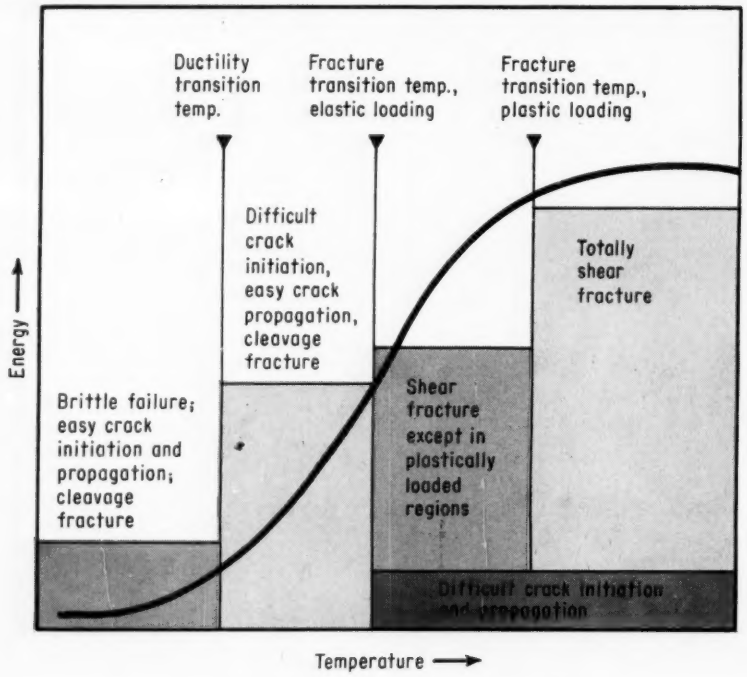
Decrease in ductility is slight or negligible even at −100 F. if the structure under test is smooth and unnotched. In the presence of a sharp notch, however, ductility may drop to such a low value for some steels that their service performance may be classified as brittle even at room temperature. The terms "notch ductility" and "notch toughness" are both used to describe behavior in the presence of a notch, but the latter term is more common. Notch toughness is a measure of notch ductility and strength, but ductility is the governing factor.

Why Notch Toughness?

Most of the work done on evaluating notch toughness has been on carbon steels. Hence, it is appropriate to explain a few basic concepts. The V-notch Charpy impact test indicates notch-toughness behavior of steel fairly well in the presence of some sharp notch or defect, such as a gouge, weld crack, arc-strike, or a sharp discontinuity in the structure in an area of high constraint. Therefore, it is convenient to describe what is known about the various aspects of notch-toughness performance with reference to a V-notch Charpy curve as in Fig. 1.

The ductility transition temperature is that temperature below which brittle fracture may take place (in this instance, in the presence of a sharp notch); hence, be-

How to Interpret a V-Notch Charpy Curve—Fig. 1


Ductility transition temp.
Fracture transition temp., elastic loading
Fracture transition temp., plastic loading
Difficult crack initiation, easy crack propagation, cleavage fracture
Totally shear fracture
Brittle failure; easy crack initiation and propagation; cleavage fracture
Shear fracture except in plastically loaded regions
Difficult crack initiation and propagation
Energy
Temperature

low this temperature, fracture may be easily started by a small amount of deformation, and the crack will propagate readily. This transition temperature corresponds to about the 5 to 25 ft.-lb. level on the V-notch Charpy curve. The level apparently varies for different steels, and selection of the precise level is still a debatable subject. A value frequently selected for evaluation is 15 ft.-lb.

The fracture transition temperature for elastic loading is that temperature above which fracture propagation (and hence initiation) is not likely to take place unless stresses are so high that the structure is plastically loaded. This temperature occurs about half way up the V-notch Charpy curve and is usually about 50 F. higher than the ductility transition temperature. Between the ductility and fracture transition temperatures, initiation is difficult and must be forced; but, once initiation does occur, propagation will take place readily and rapidly.

The fracture transition temperature for plastic loading defines the limit above which fracture is ductile (by shearing) even under plastic loading. This transition temperature is important only in unusually severe situations involving very high stresses.

Is Notch Toughness Needed?

For many applications, it is quite satisfactory to operate at temperatures as low as the V-notch Charpy ductility transition temperature. Where a greater degree of safety is desired because failure would be extremely costly and hazardous, it is better to select material so operating temperatures would be above the fracture transition temperature for elastic loading.

Notch toughness alone does not govern service performance. Performance also depends upon design and fabrication practices. When fabrication is good enough to avoid areas of high constraint and sharp notches, a structure may perform satisfactorily well below the ductility transition temperature for a sharply notched specimen. This has frequently been the case. The ductility transition temperature is not a constant temperature, but one that decreases as notch severity decreases.

As-welded structures contain high residual stresses. In the presence of cracks or notches, such structures may fail brittlely at a nominal stress level much lower than the yield point, if the operating temperature is below the V-notch Charpy ductility transition temperature. Tests of large welded plates containing sharp cracks have demonstrated, however, that brittle fracture at stresses below the nominal yield point is not likely to occur at low temperatures if the structure is fully stress-relieved. Thus, effective stress relieving provides a safeguard against the start of brittle fracture and makes notch toughness of steel a less important factor for many applications.

Riveted structures are less likely to fail in a brittle manner than welded structures. This is because residual stresses are not as high and there's no continuous path for crack propagation.

Also, small-size structures are less likely to fail brittlely because the amount of constraint is not as severe as in large structures.

It is apparent that considerable judgment must be exercised in deciding, for a particular application, whether notch toughness is an important factor, and, if so, what the criterion of performance should be.

What Affects Toughness

In carbon steels, the principal means of lowering the transition temperature (improving notch toughness) through changes in composition are by adjustments in the carbon, manganese, silicon, and aluminum contents. Carbon raises the transition temperature and manganese lowers it. Silicon and aluminum are added as deoxidizers; hence, their levels are largely determined by deoxidation requirements. Silicon-killed steel has slightly better notch toughness than semikilled steel, and silicon-aluminum-killed steel has still better toughness.

Lower transition temperatures are also obtained with a finer ferrite grain size. A finer grain size is produced as the thickness of the final hot-rolled product decreases. Thus, thin, hot-rolled material will have a lower transition temperature than thick material.

Normalizing at 1,600 to 1,700 F. will improve notch toughness when it refines the grain size. Normal-

izing is usually beneficial for thick material whose grain size is coarser than a thin product in the hot-rolled condition. Normalizing of thin material may not improve toughness characteristics. For silicon-aluminum-killed steel, however, normalizing lowers the transition temperature even for a thin product, because of a substantial decrease in grain size.

Quenching, followed by tempering at a high temperature of about 1,100 to 1,200 F., produces the best notch toughness possible in a ferritic steel if martensite can be produced in the quenching operation—in general, the lower the temperature at which the steel transforms from austenite to ferrite, the better the toughness after tempering. Carbon steel has insufficient hardenability to transform to martensite, however, except in relatively thin sections. Even so, accelerated cooling is likely to improve toughness and strength in thick material.

Cold working or deforming the steel, as in certain fabrication operations, will tend to raise the transition temperature. Subsequent stress relieving at 1,200 F. will restore most of the original notch toughness, but full recovery comes only with normalizing.

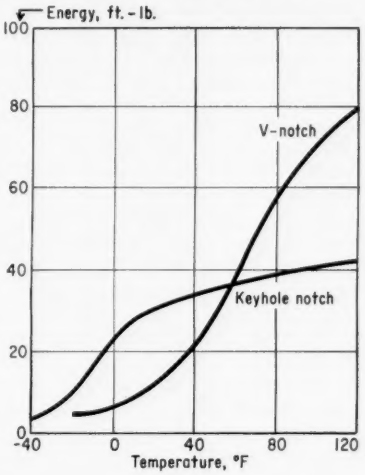
The above general rules should help to explain the differences in transition temperature of the carbon steels to be discussed. They should also indicate the advantages to be gained from heat treating either the as-received steel or the fabricated product.

Carbon Steels Available

The table lists typical compositions and grades of carbon-steel plate and their approximate average 15 ft.-lb. V-notch Charpy (ductility) transition temperatures. All steels except the last one are manufactured in the U. S. The last steel is a British Standard steel and is made under various trade names in several European countries; it has the best notch toughness available in a commercial carbon-steel product.

These transition temperatures are not to be interpreted as minimum operating temperatures. In the first place, they are only averages and in some instances (such as for A 373 steel) are based upon very limited information. For any particular grade, the range of transition temperatures from numerous heats would very likely extend 30 F. above and below the average. Second, the correlation between test data and service performance is not sufficiently well established at this time. Third, safe operating temperatures depend not only on notch-toughness characteristics but also on design, fabrication practices, and other factors. In addition, many specifications do not call for any impact requirements; hence, the notch-toughness data are listed for information only.

Compare V- and Keyhole-Notch Impact Data—Fig. 2

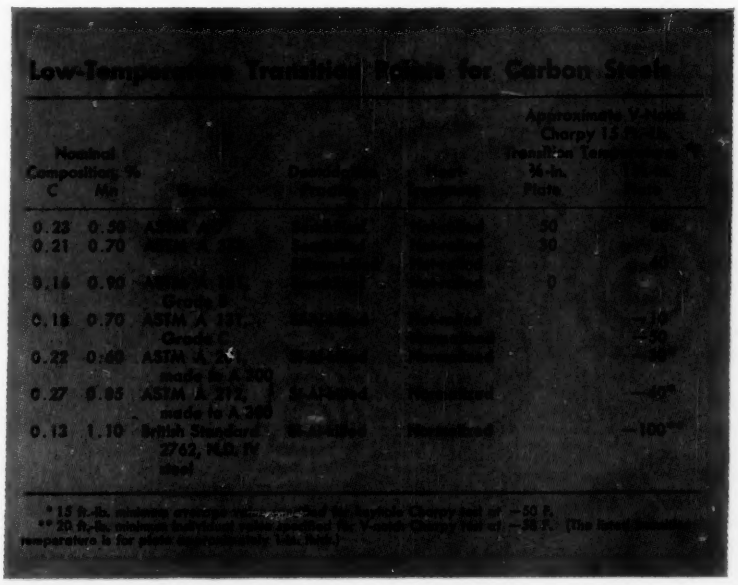


Meet Impact Requirements

The only carbon-plate steels manufactured in the U. S. to impact requirements are Grades A 201 and A 212 pressure-vessel steels, when made to ASTM specification A 300. As the table shows, the requirement is an average value of 15 ft.-lb. minimum in the keyhole Charpy test at −50 F.

Keyhole tests and V-notch tests give impact transition curves of quite different shape, and the usual relationship is depicted in Fig. 2. For this reason, 15 ft.-lb. at −50 F. in the keyhole Charpy test would be roughly equivalent to 15 ft.-lb. at 0 or at 10 F. in the V-notch Charpy test.

The A 201 and A 212 pressure-vessel steels (made to A 300) are recommended for use at temperatures as low as −50 F., and they have performed well under such conditions. Recently, considerable thought has been given to whether −50 F. is too low as a safe operating temperature when the V-notch Charpy 15 ft.-lb. temperature may be higher than −50 F. This is a difficult matter to resolve in view of the generally satisfactory performance record, but other factors


Low-Temperature Transition Points for Carbon Steels

Nominal Composition, % C	Mn	Specification	Grade	Deoxidation Practice	Heat Treatment	Approximate V-Notch Charpy 15 ft.-lb. Transition Temperature, °F, 3/4-in. Plate
0.23	0.50	ASTM A 285	A	Semi-killed	As-Rolled	50
0.21	0.70	ASTM A 285	B	Semi-killed	As-Rolled	30
0.16	0.90	ASTM A 285 made to A 300	Grade B	Semi-killed	As-Rolled	0
0.18	0.70	ASTM A 181	Grade C	Semi-killed	As-Rolled	−10
0.22	0.60	ASTM A 285 made to A 300	Grade C	Semi-killed	As-Rolled	−30
0.27	0.85	ASTM A 212 made to A 300	B	Al-Killed	Normalized	−40*
0.13	1.10	British Standard 2762, N.D. IV steel	Al-Killed	Al-Killed	Normalized	−100**

* 15 ft.-lb. minimum average value obtained in keyhole Charpy test at −50 F.
** 20 ft.-lb. minimum individual value obtained in V-notch Charpy test at −50 F. (The listed transition temperature is for plate approximately 1/2 in. thick.)

are also involved. For example, many of the vessels are stress-relieved, and all are carefully fabricated and inspected to avoid cracks or defects.

On heavy-walled pressure vessels for critical applications, one company has specified a requirement of 15 ft.-lb. minimum in the V-notch Charpy test at +10 F. A steel similar to ASTM A 212 Grade B is specified as well as accelerated cooling (spray quenching with water) and tempering. This combination of treatments provides somewhat better notch toughness than normalizing so the impact requirement can be met readily for thick plate.

The British N. D. IV steel is much better in Charpy notch toughness than the American grades, because of lower carbon and higher manganese. It is included simply to indicate the degree of toughness available in normalized carbon-plate product. To date, however, demand for this steel has not warranted production in this country.

The only seamless and welded carbon-steel pipe or tubes made to guaranteed impact properties are those manufactured to ASTM specifications A 333 and A 334. Again, the requirement is 15 ft.-lb. in the keyhole Charpy test at a minimum temperature of −50 F.

Structural shapes are made from steel conforming to ASTM A 7 or A 373. There are no notch-toughness requirements. Such steel has performed well in service even at low atmospheric temperatures of about −50 F. Perhaps this fact emphasizes that many factors influence service performance other than notch toughness as evaluated by sharply notched laboratory specimens.

Carbon-steel sheet product is not impact-tested and should be suitable for use at quite low temperatures, because notch toughness is not believed to be an important consideration for thin materials.

Welding: Weak or Strong Link

In any welded, continuous structure, the weld should be as tough as the base metal. If this is not the case, fracture will occur preferentially through the weld or the weld heat-effected zone.

Few tests have been conducted that suitably evaluate the over-all performance of weldments; but these few show welds made with E 6010 electrodes (a common type for welding carbon steels) on mild steel have ductility transition temperatures of approximately 0 F. Since a weldment is no better than its weakest link, plate welded with E 6010 electrodes might undergo brittle fracture through the weld at temperatures below 0 F., even though the base plate had excellent notch toughness. Therefore, material such as the British N. D. IV steel should be welded with an electrode that deposits weld metal tougher than E 6010 so that better advantage can be taken of the good notch toughness of the base plate.

Because there is a lack of critical test data, it is difficult to recommend toughness needed in electrodes for welding American carbon steels with increased notch toughness. It would seem that a steel such as normalized ASTM A 131 Grade C could be used with greater safety at temperatures below 0 F if a tougher electrode than E 6010 were used, such as an alloyed low-hydrogen electrode.

Welding involves so many factors that it is difficult to lay down any general rules. One suggestion may help, however, to indicate when special welding practices may be needed to avoid underbead cracking in the heat-affected zone of a weld. In general, cracking may occur in carbon steels when welding with cellulose-covered electrodes (such as E 6010) if the %C + %Mn/6 exceeds about 0.40. If %C + %Mn/6 exceeds 0.40, either continue using the cellulosic electrodes and preheat, or use low-hydrogen electrodes without preheat. Under severe constraint, preheating may be called for even with low-hydrogen electrodes.

Some people believe that silicon and aluminum also adversely effect weldability and should be included in the above formula. But available data are not definitive enough for such a move at this time. Actually, many more data are necessary before any decision can be made on this point.

The ASTM A 212 Grade B steel will usually require special welding precautions because of its relatively high carbon and manganese contents. The other steels may call for precautions at times, depending on actual composition, welding practices and material thicknesses involved in fabrication.

Costs Are Not High

The costs for carbon steels depend not only upon composition but upon quality of steel supplied (such as structural, flange, or firebox quality) since the amount of testing varies for each.

ASTM A 373 and A 131 are structural-quality steels on which a minimum number of tests are conducted, and no impact testing is specified. Hence, these steels are not much more costly than A 7 steel. The most costly steel of this group is A 131 Grade C, which costs about 20% more than A 7.

The A 201 and A 212 grades, made to A 300, are flange and firebox qualities with tests conducted on each plate, including impact tests. These steels cost about 75% more than A 7 steel.

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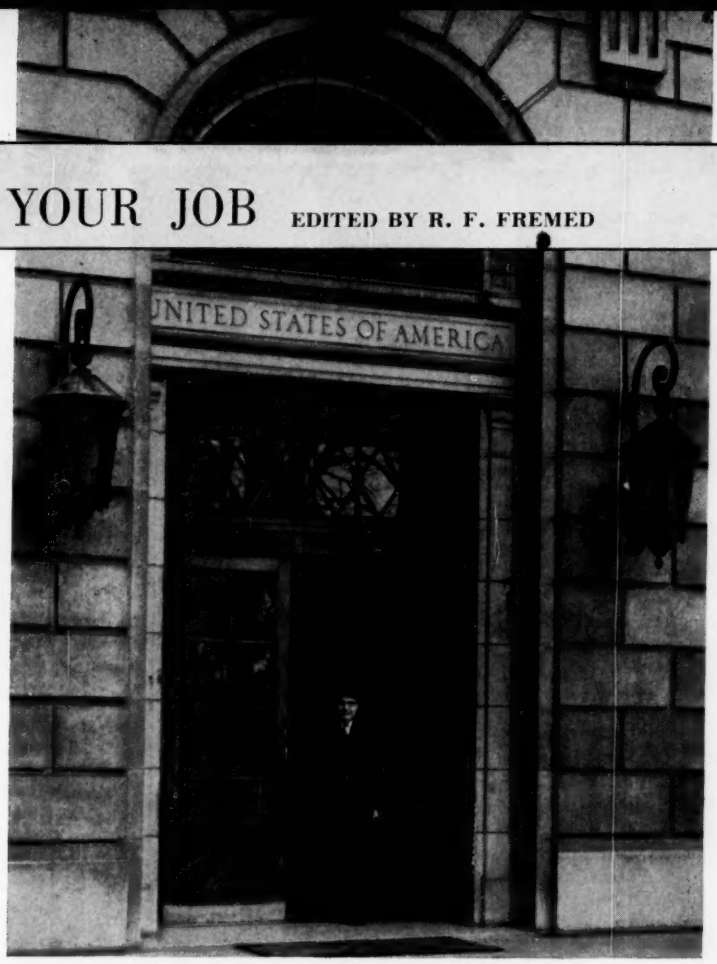
R. W. VANDERBECK graduated from Princeton University with a B.S. in 1940. He was then employed by Allegheny Ludlum Steel Corp. as a research metallurgist until 1944. Since that time, he has worked for U. S. Steel, first as a research assistant and later as a research associate in the Pittsburgh general office. He currently is chief research engineer, structural and plate, at the Applied Research Laboratory in Monroeville, Pa.



U. S. EMBASSY, PARIS. Another busy day begins for . . .

FRANCE
SCIENCE
UNITED STATES *of* AMERICA

The Chemical Engineer Turned Diplomat

Today, scientific attaches in key locations help shape our foreign policy. Here's an exclusive report on how it's done.

ARTHUR ERIKSON, McGraw-Hill World News, Paris, France.

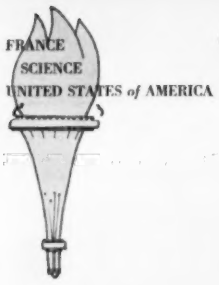
Anything from Sahara vegetation to satellite projects can pop up during the working day of Edgar L. Piret.

He's the chemical engineering professor from Minnesota who turned diplomat just about one year ago for a tour of duty as scientific attache at the American Embassy in Paris.

The switch from mortarboard to top hat (gray Homburg for daytime) has carried Piret from the relative quietude of a campus in Minneapolis into the turbulent mainstream of high-level diplomacy. His reputation in the chemical engineering profession is based on a remarkable record in the field of chemical-reactor theory and design.

As scientific attache, his ken has opened outward to include practically every field of engineering and science—the two major exceptions are atomic energy and military weapons—for he must advise the Ambassador on technical matters in general.

Across-the-board awareness of technological developments is also the key to effectiveness in the other important phases of the job, for which State Dept. labels read "evaluating the interaction of science with foreign



"Help the other fellow do his job," Piret says,

PIRET watches for misleading reports about U. S. science.

IDEA IS to kill inaccuracies before they appear in print.

policy" and "improving liaison between U. S. personnel and foreign scientists and engineers."

Scientific attaches are now serving in such important locations as London, Rome, Bonn, Stockholm, Toyko, Moscow, Delhi and Brasilia as well as in Paris. Eventually, our State Dept. expects to have both a science officer and a deputy in each post (*Chem. Eng.*, Jan. 26, 1959, p. 128).

▶ **Casual Formality**—Piret keeps on top of developments mainly through contacts he has developed among key engineers and scientists in French government circles and industry. His appointment calendar reads like a "Who's Who in French Science."

One name often jotted down is that of the De Gaulle government's science kingpin Pierre Piganiol. Piret describes him as the "Jim Killian of France." Piganiol started his career in chemistry and then moved on to a government post.

Although Piganiol operates under the imposing title of Delegue General a la Recherche Scientifique et Technique, and Piret ranks as a Special Assistant to the Ambassador, their working basis is the informal, factual kind common among technical men but rare at middle-management levels of bureaucracy. Here's a typical example:

Recently Piret, doing some spadework for an analysis of French government research and development spending, dropped in on Piganiol to clear up several puzzling points in the 1960 science budget. Piganiol, who in effect controls the purse strings on research funds and therefore navigates with a certain sureness through the intricate maze of state finance, answered the budget questions easily.

During the general conversation that followed, he handed Piret an overstuffed file folder. It was a report on experiments performed by a French physicist who claims he has detected a periodic variation in the order of 10^{-8} in the force of gravity. Piganiol explained that some scientists in France question the validity of the results. He asked Piret to take the dossier with him and, when he had a chance, look it over to see if the results were interesting enough to warrant a cross-check by physicists in the U. S.; or additional research in France financed by the U. S.

In this atmosphere of casual formality Piret who had come to see Piganiol about the science budget, walked out with a potential Franco-American research project in his briefcase.

▶ **A Technical Ambassador** — The knowledge Piret gleans from personal contacts and from a diligent reading of the French scientific press is passed onward, and often upward, in a variety of ways. For one thing, Piret reports directly to Ambassador Amory Houghton, former Corning Glass board chairman, and no stranger to technical briefings.

They meet every two weeks for a 30-min. session during which Piret brings the Ambassador up to date on important technical developments in France, with special emphasis on sensitive sectors, such as space research, that can affect foreign policy.

At a recent (and representative) meeting, Piret explained the tax inducements made by the government to encourage research by French industry. He also pointed out the moves made by the Association Nationale de la Recherche Technique to work out a way for medium-sized industrial companies to get done the research they'll need to meet competition from industrial giants in the upcoming struggle for survival in the European Common Market.

Piret topped off the session with a roundup of research activities in France of 30-odd U. S. Government offices and international organizations to which the U. S. belongs. On important developments like tax incentives for research, he often backs up the condensed information with comprehensive dispatches that wind up in the mail pouch headed for State Dept. headquarters in Washington. These eventually turn up on the desk of Wallace R. Brode, Science Advisor to the Secretary of State.

▶ **A Commodity Broker**—Acting as a science consultant for the Ambassador is only a part of Piret's job. Along with his as-

"and you'll usually find you're doing your own too."

PIGANIOL and Piret: Their working basis is informal and factual.

NAVIGATING through the intricate maze of government finance.

CASUAL BIRTH of a new Franco-American joint research project.

sistant, retired Swarthmore organic chemistry professor Edward Cox, he operates a sort of brokerage house dealing in practically any commodity—men, information, ideas, even attitudes—that involve science, France and the United States of America.

Among other things, Piret and Cox have: supplied for a visiting U. S. Ambassador an analysis of the French attitude toward Russian space projects; bagged a leading French electronics professor for the American Institute of Physics visiting lectureship; shepherded through the Embassy visa section applications of French scientists headed for the International Oceanographic Congress and similar professional meetings in the U. S.; screened candidates for Fulbright awards.

Also, they have: selected American technical books for translation into French; helped inventors export their patents to America; assisted an astronomer from the National Bureau of Standards laboratory at Boulder, Colo., who was interested in the sun-temperature measurements being made at the Paris Institute of Astrophysics; aided and abetted a French researcher looking for anthropo-biomedical data on American college students.

PIRET (left) REPORTS directly to Ambassador Amory Houghton.

▶ **The Coordinator**—Another of Piret's functions is to coordinate the scientific activities of U. S. government departments and offices in France. For that reason, his office on the second floor of the Embassy building (just off the Place de la Concorde) sees a constant flow of people from ONR, NASA, NSF, ARDC,

NATO, and a score of other alphabet-taxing organizations.

A list of recent visitors includes: George Kistiakowsky, President Eisenhower's science advisor; Immanuel Estermann, science director of the ONR London office; and I. I. Rabi, U.S. representative on the NATO science committee.

One of the best-known names on the visitors' register belongs to a phantom—the mathematician Bourbaki of the non-existent University of Nancago. The publisher of the Bourbaki series of books on higher mathematics asked Piret for leads on possible distribution of the books in America.

▶**Packs Some Weight** — In the hierarchy of the State Dept., the scientific attache is pegged at the FSR-1 level, the grade just below minister. As such Piret packs enough diplomatic weight to sit in on negotiations at the Quai d'Orsay when the agenda includes items like a cooperative French-American space project.

And when the Foreign Office wanted some help with the English-language version of its "French Science News" bulletin, it naturally pounced on Piret and Cox. They gladly pitched in and even turned up a science writer for the bulletin. "Help the other fellow do his job," Piret says, "and you'll usually find you're doing your own too."

▶**The Other Fellows**—Some of the "other fellows" at the Paris Embassy are the people of the U.S. Information Service (USIS), whose job it is to keep sunnyside-up, as much as possible, news about America in the French press. Piret watches for inaccurate or misleading reports about U.S. science; helps USIS get the facts to the press. (In the French press, space shots and satellites receive the same front-page play as public moves by General de Gaulle, and domestic ones by Brigitte Bardot.)

Piret checks too, for USIS, on how the competition is doing in French newspapers and magazines. In one month alone, he noted in a dispatch to Washington nine news items reported as Russian "firsts" in science and technology. They included: an altitude record for the T-431 aircraft, which climbed to 28,760 meters in 25 min.; discovery of an antigrippe vaccine; development of a camera that takes a million pictures a second; and turbo-drills made of plastic for oil-well drilling.

As a result, Piret has opened the doors to his office and the considerable information at his disposal to leading science writers for the French popular press. The idea is to kill inaccurate reports before they appear and to stimulate stories about U.S. science.

▶**Still a Researcher**—Piret's job at the Embassy keeps him hustling, but he still manages some after-hours work on research papers in reaction kinetics and chemical engineering reactor design. He has four in the hopper now, all in conjunction with former students at the University of Minnesota.

Another current project is a lecture on chemical-reactor design for the annual series of chemical engineering lectures sponsored by the Societe de Chimie Industrielle. The speakers for this year's series were lined up by the Science Attache of the American Embassy, who didn't have to look very hard for a top man in chemical-reaction kinetics.

The background that 49-yr.-old Piret draws on for his demanding job is practically tailor-made. He holds two doctorate degrees, one from Minnesota and one from the University of Lyon. More than 55 patents and publications helped win for him the Walker Award of the American Institute of Chemical Engineers in 1955. And he has considerable industrial experience, most of it with Minnesota Mining & Manufacturing Co.

Just as important for a post where contacts with French scientists are indispensable, he speaks French well, although not flawlessly. Even before he returned to France as Scientific Attache last year, Piret was well-known among the science community as a result of Fulbright teaching in 1950-51 at Paris and Nancy.

This got him off to a fast start in the Embassy job. And there are certainly no signs yet of a slowdown for this chemical engineer turned diplomat.

SALARIES

. . . *Way Up for Beginners*

Most predictions about starting salaries for 1960 engineering graduates have already proved to be incorrect.

They were too low.

This report from John G. Young, College of Engineering Placement Office, Univ. of Michigan, tells the story:

"General demand is very good, and higher than last year. Companies visiting us have so far increased 6% over 1959 totals. Salaries, well past early estimates of a 1.8% average increase, are up 5%, generally raising average monthly earnings for bachelor-degree holders from $508 to $535.

"For master degrees, salaries are up from $601 to $621.

"Greatest demand is for electrical engineers, whose salaries will average $547/month to start."

IN SPACE

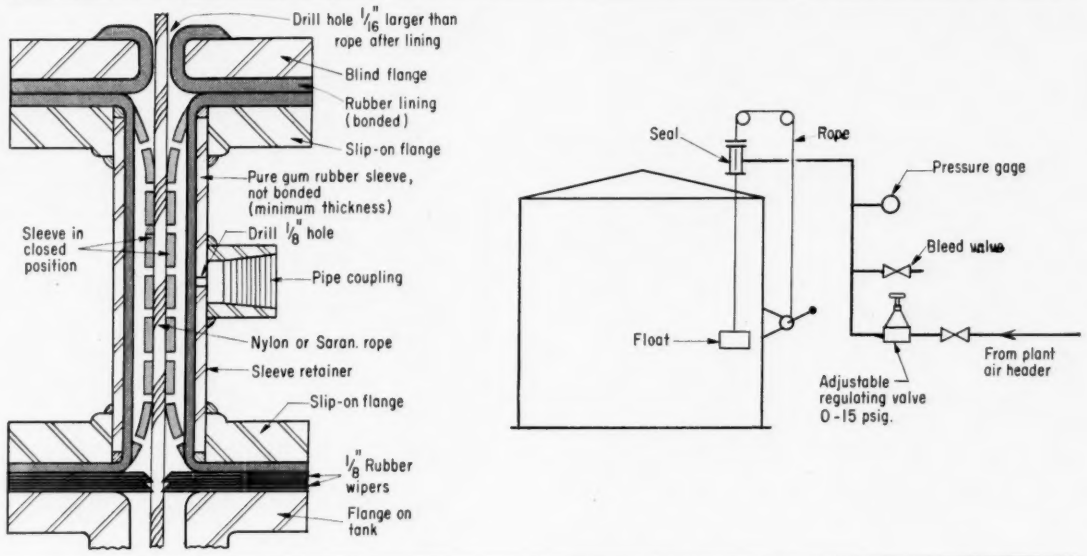
. . . *You Have Key Role*

Increased recognition accorded to the scientist has had the unfortunate side effect of a decline in the public mind of the importance of the engineer, according to the Chief Scientist of the U.S. Air Force.

Alexander H. Flax declared in a major speech last month that while science is achieving public recognition and support, "the importance of engineering has to some extent been eclipsed." He attributes the decline in engineering enrollments "to this cause, at least in part."

Flax, who holds a doctorate in physics, also said that "because of the loose usage of the term scientist in connection with space vehicles, the public image of the man responsible for space vehicles is that of a physicist or a chemist rather than that of an engineer.

"No one will deny the contributions of physicists and chemists to space propulsion and space vehicles, but the role of the engineer is a central one and this fact is often lost sight of."



Inflated Sleeve Seals Tank Gage Rope

This tank was padded with chlorine at 2 in. w.g. vacuum and sealing the gage rope was a problem. Air pressure on a rubber sleeve did the trick.

★ **Winner of the March Contest by**
W. E. Robertson
Senior Project Engineer, Central Engineering Dept., Diamond Alkali Co., Cleveland, Ohio.

During the initial startup of one of our company's plants we recently had difficulty with the seals on a tank level gage. The main problem stemmed from the fact that the tank to be gaged contained a pad of chlorine gas at a normal operating vacuum of 2 in. water gage. It was necessary to use a seal since air leakage into the tank was undesireable.

Various seals failed due to the corrosive nature of the wet chlorine gas. It was possible to build or to purchase expensive seals but delivery as well as cost was a problem and we needed a solution immediately. This caused us to design a seal, illustrated above, which has proven to be both practical and inexpensive in service.

Operation of the seal is very simple. When the operator wishes to lower the float, he closes the air valve and opens the bleed valve. This causes the pure gum rubber sleeve to release its hold on the nylon or Saran rope, thus breaking the seal. The combination of the wipers shown, and the small annular space around the rope at the top of the seal, keeps air leakage into the tank (at 2 in. H_2O vacuum) to a minimum.

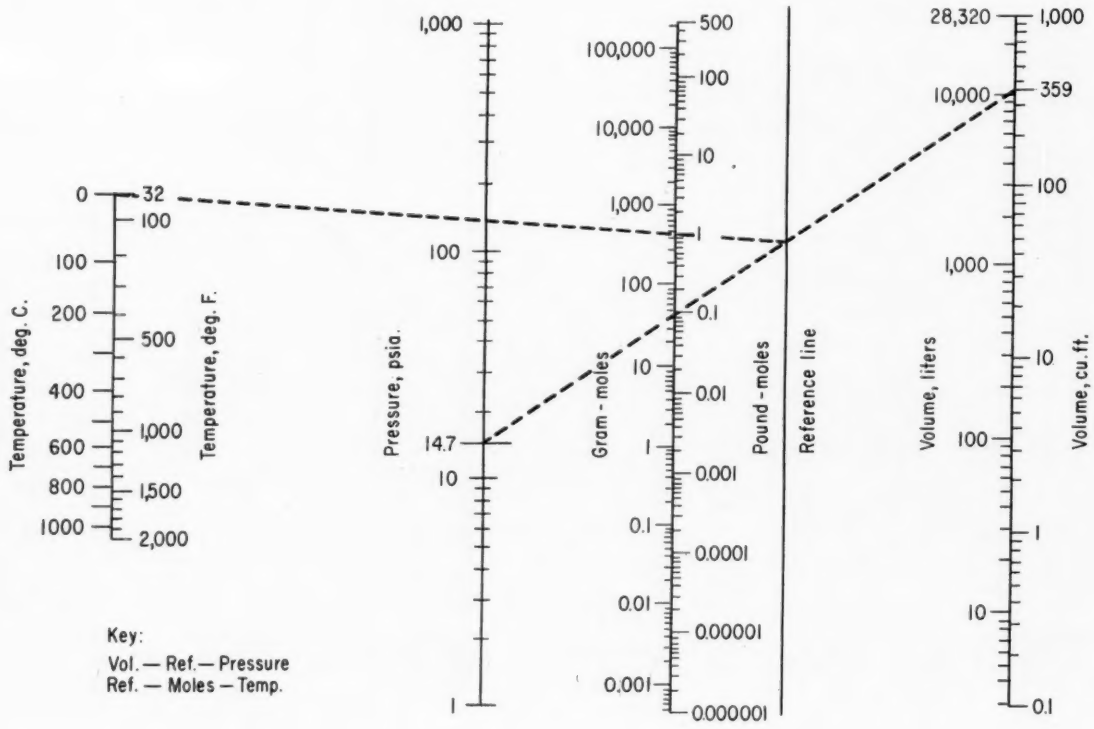
After the operator has gaged the tank and raised the float he merely closes the bleed valve and opens the air feed to the seal. The closure action of the seal is extremely tight.

Fabrication of this device is relatively simple for a skilled rubber fabricator. Our sleeve had a vulcanized seam in it and this did not appreciably affect its operation. The thinner the sleeve, of course, the better. One consideration in regard to the

thickness of the sleeve is that it must be flexible enough to allow its insertion into the retainer.

The wipers, however, should be fabricated of relatively stiff rubber stock. The hole in the wiper should be $\frac{1}{16}$ in. smaller than the rope and it should be cut to produce a sharp edge on the hole as shown in the sketch.

There are doubtless other uses also for this same idea.



Save Time With Gas-Law Nomograph

Tom Loy and
Richard R. Palumbo

Columbia-Southern Chemical Corp.
Barberton, Ohio.

Appearing above is a nomograph based on the ideal gas law. Knowing any three of the four variables: Pressure, volume, temperature and number of moles, it determines the fourth.

The nomograph converts volumes from cubic feet to liters, temperatures from Fahrenheit to Centigrade, and weights from pound-moles to gram-moles, and vice-versa. It needs no correction for absolute temperature; it's a time saver for repetitive calculations; and it can be used by the non-technically trained.

Next Issue: How to Reduce NO in Inert Gas

By T. W. Miller, Winner of the April Contest

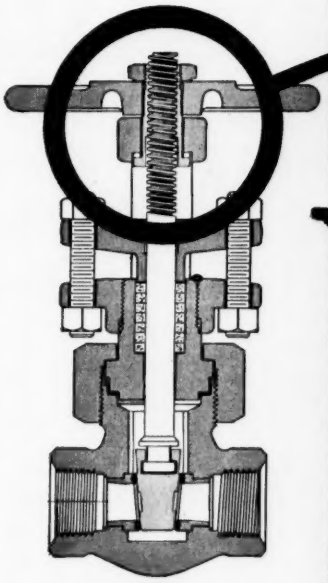
★ How Readers Can Win

$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Process Design Notebooks. Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Process Design Notebooks, *Chemical Engineering*, 330 W. 42 St., New York 36, N. Y.



heat and wear resisting

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Heat and wear-resisting *stainless steel* yoke nuts in Vogt Valves give longer trouble-free service. We have proved this in our own "Torture Chamber," under constant and accelerated testing, as well as in tough service applications. They are made from a special stainless steel alloy having excellent bearing quality, matchless strength, and a melting point of approximately 2700°F.

The rotating gate valve yoke nut design, illustrated, has flats for a tight fit with the square broached hole of the handwheel. Non-rotating yoke nuts, for globe and angle valves, are of the same superior design and quality. Vogt GP Valves are available in a complete range of sizes from 1/4" to 2" and rated 800 pounds at 850°F. and 2000 pounds at 100°F.

Catalog F-10 is available to you—please send request on your company letterhead. Address Dept. 24A-FC.

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FORGED STEEL

VALVES

CE COST FILE

No. 32: Estimating Engineering Drafting Costs

Donald F. Brosnan, New York, N. Y.

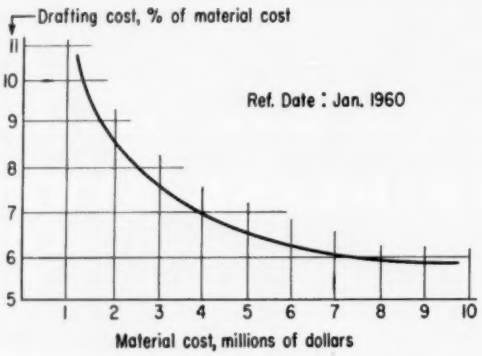
Three Ways to Estimate Cost of Drafting

Design drafting costs can be estimated like other capital costs. And capital cost estimates group conveniently in several accuracy ranges depending on data available at time of estimate. We'll consider three methods of estimating drafting costs characterized by following accuracies:

Scope (order-of-magnitude)	+50% to −30%
Budget (appropriation)	+30% to −15%
Definitive	+15% to − 5%

▶ **Scope Estimate**—The method used to estimate drafting costs for a scope estimate should be quick and convenient to use. Drafting costs, consisting of drafting salaries and overhead, are easily estimated as a percentage of total material costs. But careful study of material costs should be made to eliminate "package" units whose engineering is done by vendors.

Drafting costs can be estimated from the graph below. Overhead (workmen's compensation, social security, vacations, holidays, company benefits, insurance, office supplies, etc.) is included at 60% of drafting salaries.



Data are based on 40-50 petroleum and petrochemical plant projects, most of them additions of new units to existing refinery facilities.

Example—For crude distillation unit: estimated total material, $6,400,000; (from chart) drafting cost is 6.1% of material; estimated total drafting budget is $390,000.

▶ **Budget Estimate**—A more reliable estimating procedure can be based on expenditure for piping, the design category requiring by far the most drafting effort. An accurate estimate of piping drafting cost plus an experience factor to allow for remaining drafting gives a fairly reliable figure. Here's how it's done:

Estimate number of piping man-hours required by determining number of piping drawings required and multiplying by 340 man-hours/drawing. Latter factor, based on average of 2,000 piping drawings, is from author's experience.

Estimate what percentage of total drafting is piping drafting. For most refinery units, piping drafting varies from 38-45% of total drafting. For units in which process requires high operating pressures or significant amount of bulk material handling, piping drafting is 30-35% of total.

Multiply piping drafting man-hours by average drafting rate ($4/hr.) and add in overhead at 60% of total piping drafting salaries.

Example—For crude distillation unit: estimated total material, $6,400,000; estimated number of piping drawings, 75. Piping drafting requires 75 × 340 man-hours, or 25,500 man-hours. Estimate piping drafting man-hours as 40% of total. Total drafting man-hours is thus 63,750 man-hours. Cost, at $4/hr, is $255,000; overhead adds $153,000 for a total drafting budget of $408,000.

▶ **Definitive Estimate**—All information available to the estimator should be used in the most reliable estimate. Completely plan number of drawings required in each drafting category and apply following factors:

Normal % of Sub-total	Category	Man-Hr./ Dwg. Range	Avg.
3–5	General (plot plans, etc.)	800–1,400	1,000
2–3	Buildings	170–230	190
10–12	Electrical	180–240	210
12–14	Foundations and underground	150–220	180
6–7	Instruments and instr. piping	170–250	200
38–45	Piping	300–400	340
4–5	Pipe supports	180–250	220
7–9	Vessels	90–150	120
5–7	Structural steel	150–230	170

Add 20% to sub-total for supervision and requisitions.

Example—For crude distillation unit: estimated total material, $6,400,000. Use average man-hr./drawing.

General	2 Drawings	2,000
Buildings	6 Drawings	1,140
Electrical	24 Drawings	5,040
Foundations & underground	36 Drawings	6,500
Instruments, etc.	16 Drawings	3,200
Piping	75 Drawings	25,500
Pipe supports	13 Drawings	2,860
Vessels	33 Drawings	3,960
Structural steel	22 Drawings	3,740
	Sub-total	53,940
Add 20% for supervision		10,790
		64,730

At $4/hr., 64,700 man-hr. is $258,800; overhead adds $155,300 for a total to $414,000.

In any of above methods estimator should frequently check costs on units of similar design, be in contact with current drafting productivity and generally be familiar with his own company's costs.

Head for Houston!

Fourth annual meeting of the American Association of Cost Engineers will be held in Houston at the Rice Hotel, June 13-15. Most papers and workshops at the meeting will be directed to, and presented by, process industry representatives. Items of particular interest to readers of Cost File in the meaty technical program include cost estimation workshops on preliminary estimating of chemical plant equipment, short-cut estimating of off-site facilities, and estimates from cost-capacity curves. Try to attend this important cost meeting!

Wagner Vertical Solid Shaft Motors...

POWER PACKED PUMP DRIVES

Got pump-power problems? You can solve them—simply, easily—with Wagner Vertical Solid Shaft Polyphase Motors. These motors are designed especially to meet the load conditions of pumping. They handle loads without laboring or stalling... are smooth running under cyclic loads. They are uniquely suited, too, for other types of equipment that require vertical motor drives. Match them to agitators, axial fans, centrifuges, mixers, presses ... anywhere you need a vertical shaft motor.

Whatever the application, one thing is sure... Wagner advanced design engineering has produced vertical shaft motors of simple, rugged cast-iron construction... motors with plenty of stamina to give you economical, maintenance-free service the year 'round, indoors or out.

Wagner Vertical Solid Shaft Motors are end-mounted, squirrel-cage type with NEMA Type "P" base. They are available in standard ratings of 60 cycle, 208-220/440 and 550 volt, 1½ through 40 hp—3500 RPM, and 1 through 30 hp—1750 RPM. For information on larger horsepower ratings, call your nearby Wagner Sales Engineer.

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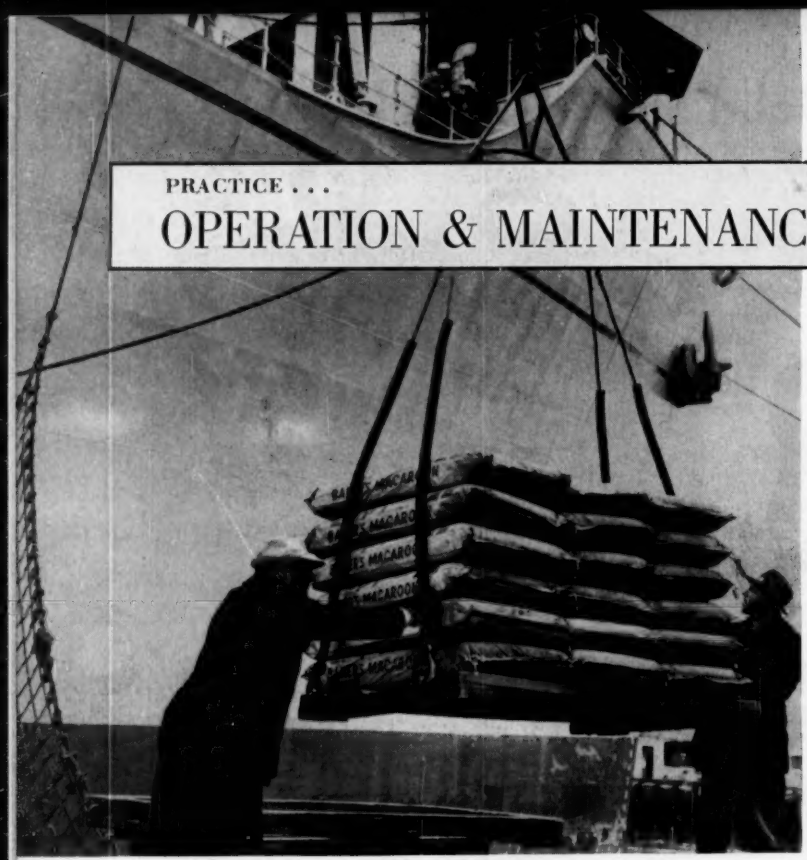


How to select the right . . .

Multiwall Paper Containers

Thomas E. Dowling, Packaging Section, American Cyanamid Co., N. Y.

As the table on p. 118 will show you, there are many different multiwall paper bags suitable for as many different types of service and products as you can name. How then does one make an intelligent selection for a particular product and service?

Our first article on this subject told you what a multiwall paper bag is. In this article, we will tell you how to select the proper bag for your purposes. So let us select a hypothetical product, endow it with certain characteristics and qualities, and design a bag to fit.

Suppose, then, we have a dry, free-flowing granular product. It has a bulk density of about 60 lb./cu. ft. and is moderately hygroscopic. We plan to produce about 60 to 70 million lb./yr. with about half going to overseas markets and about half to domestic markets. We intend to sell it as a chemical intermediate in large quantities and not to a consumer market and will sell it for about thirty cents per pound. There is no hazard associated with its handling or use.

▶ **We Have a Wide Choice**—A dry, free flowing granular product is one of the simplest forms of material to pack in bags, so we have a wide choice of equipment and bag types.

Part I of this article, on what multiwall paper bags are, appeared in the May 16 issue.

Since we are interested in a filling speed of about 10 bags/min., and our product does not contain a significant quantity of fines and is relatively inexpensive, we will specify a valve type bag thereby eliminating the sewing and taping closing operations.

A taped and sewn closure is generally considered stronger and more dependable than a pasted closure, so we would prefer a sewn bag for the more rigorous export service. A pasted bag should be quite good enough for domestic shipments.

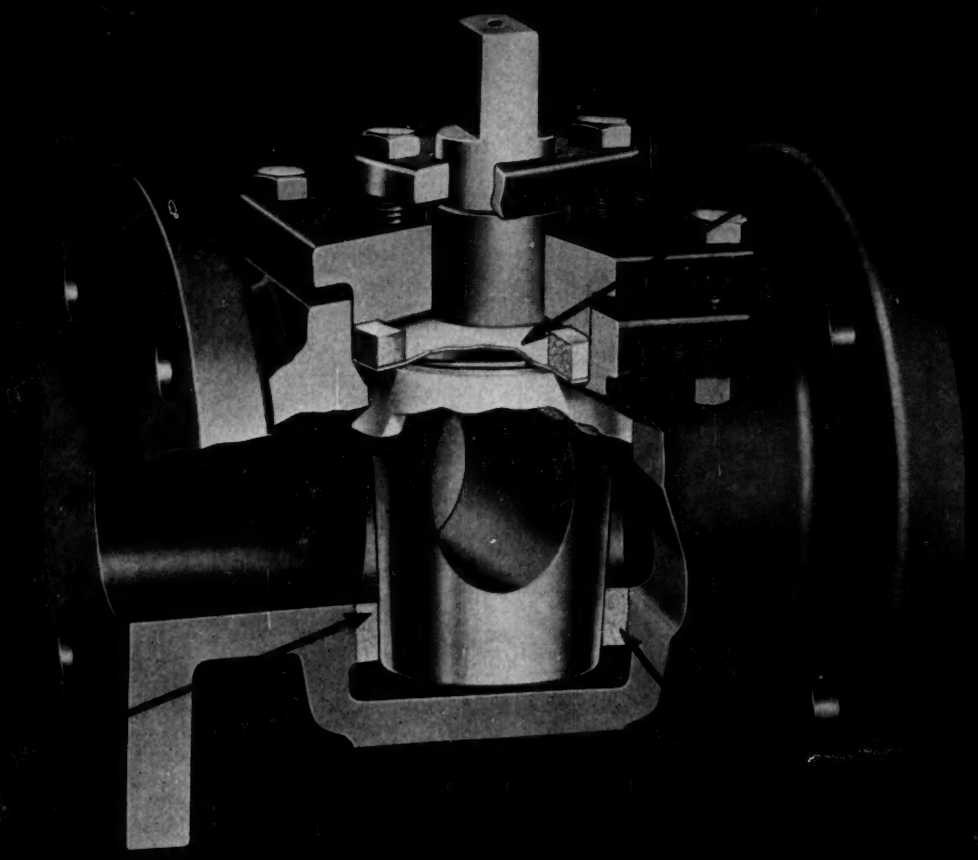
▶ **What Weight and Size?**—Next we must decide upon the net weight to be offered and calculate an approximate bag size.

In recent years, the trend has been to lighter bags for the domestic market—from 100 lb. to 80 lb. to 50 lb. per bag. Though this leads to slightly higher container costs per pound of product, the growing sentiment among labor in the packers' plants and the customers' plants is for a lighter unit. This is particularly true when a product has a relatively low bulk density and a one hundred pound unit becomes awkward to handle.

Also, when small quantity shipments are the rule instead of unitized carloads or truckloads, a lighter bag is advantageous.

In our hypothetical case, however, we have a fairly dense commodity and we generally make large volume, palletized shipments. We would therefore elect to offer 100 lb. units to the domestic as well as the export trade.

Foreign labor accepts 100 lb. units readily and by offering the same size unit to the domestic market as well as to the foreign market, we spare ourselves the inconvenience of changing bag sizes frequently on the packing equipment. We also take advantage of the savings in container



THROW OUT LUBRICATED PLUG-VALVE PROBLEMS

Install non-lubricated DURCO Type G Sleeveline valves

Wherever you have cast iron or semi-steel valves that stick, gall, break, leak thru, or otherwise cause maintenance nightmares, install ductile iron Durco Type G valves with Teflon sleeves.

Durco Sleeveline valves are available in ductile iron or stainless steel, screwed or flanged ends, from ½" through 6", with 150 psi rating.

Write today for your copy of Bulletin V/12.

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

THE DURIRON COMPANY, INC., Dayton, Ohio / Valves • Pumps • Filters • Process Equipment

There Are Many Different Bag Constructions Possible for Similar Purposes—Table I

Product	Net Weight	Construction	
		Domestic	Export
Chemical Intermediates	100	1/15PE50, 3/50, 1/70 1/50, 1/90AL, 1/50, 1/60 2/50, 1/60, 1/70 1/90AL, 3/50 2/50, 2/60	1/50, 1/90AL, 1/50, 2/60 1/40, 2/50, 1/50PE10, 1/50, 1/70
	75	1/50, 1/90AL, 2/50, 1/60 3/50, 1/60, 1/70 1/20PE50, 2/50, 1/60, 1/70	
	50	1/50, 1/20PE50, 1/60, 1/70	
Pigments	50	2/40, 1/50, 1/60 1/40, 1/50, 2/60 2/50, 2/60 1/40, 2/50	1/40, 2/50, 1/60, 1/60WS

cost per pound of product while at the same time providing ourselves with a satisfactory alternate container in the event our supply of one or the other bag should run out.

►**Select Proper Dimensions** — There are many charts and graphs available from bag manufacturers with which we can determine the approximate dimensions for a valve bag for any given weight and product density. None of them do much more than form a basis for a rough estimate, however. As an example, we have reduced a portion of the information supplied by these charts and tables to the simple table in Table I.

With Table I, we can arrive at a starting bag size for sampling purposes, but only actual filling tests will permit us to make an estimate accurate enough to order bags in quantity.

Table I tells us that for our product (density 60 lb./cu. ft.) we should consider a bag with a tube width of about 21 in. and a tube length of 32 to 34 in. Tube width is generally split between the face and gusset dimensions in any reasonable manner such as 16 x 5, 17 x 4 or 18 x 3 in. (Face width is the distance across the bag from side fold to side fold; gusset is the depth from front to back.)

Palletizing requirements generally dictate the division of dimensions, but optimum bag proportions generally have the length 1½ to twice the face width. So, for the sewn valve bag, we suggest as a starter the dimensions: Face width, 17 in.; Gusset, 4 in. and Length, 34 in.

Similarly, for the pasted bag we might begin at 22 in. by 4 in. by 32 in.

►**Valve Size Not Critical**—Selection of the valve size is not particularly critical from the standpoint of container efficiency, but depends more upon individual packing equipment requirements. The advantages of greater filling speed which might result from a larger valve opening may be offset by the greater chance of sifting or accidental contamination. Therefore, we will compromise and select a 4 in. valve opening.

Considering relative costs and other factors discussed in Part I of this article, we believe that a Style 2 valve will be satisfactory for both our domestic and export bags.

►**Sidewall Construction** — We now come to the problem of selecting the optimum sidewall construction for our bags. To aid us in our selection we have made a list of typical bag constructions

Bag Dimension Chart Is Only a Rough Guide—Table II

Product Density (Lbs./Cu. Ft.)	Sewn Valve		Pasted Valve		
	Tube Width	Tube Length	Face Width	Butt	Tube Length
25	28	45	28	5	40
30	27	42	27½	5	39
35	25	40	26½	4½	37
40	24	38	25½	4½	35
45	23	37	24½	4½	33
50	22½	36	24	4	32
55	21½	34	23	4	31
60	21	33	22	4	31
65	20½	32	22	3½	30
70	20	31½	21	3¼	29½
75	20	30	21	3¼	28½

1. This table is calculated for 100# net weight bags. For 50# net weight bags, multiply the actual product density by 2, and proceed.
2. Dimensions of bags can normally be altered without changing their capacity significantly by trading one-half inch of face or gusset width for one inch of length.
3. Above values are for valve bags. For SOM bags which are to be sewn, add about 1 in. to length. If OM bags are to be tied, or folded and stapled, add 3in.

POWELL
CORROSION-RESISTANT
VALVES

Performance makes the world of difference

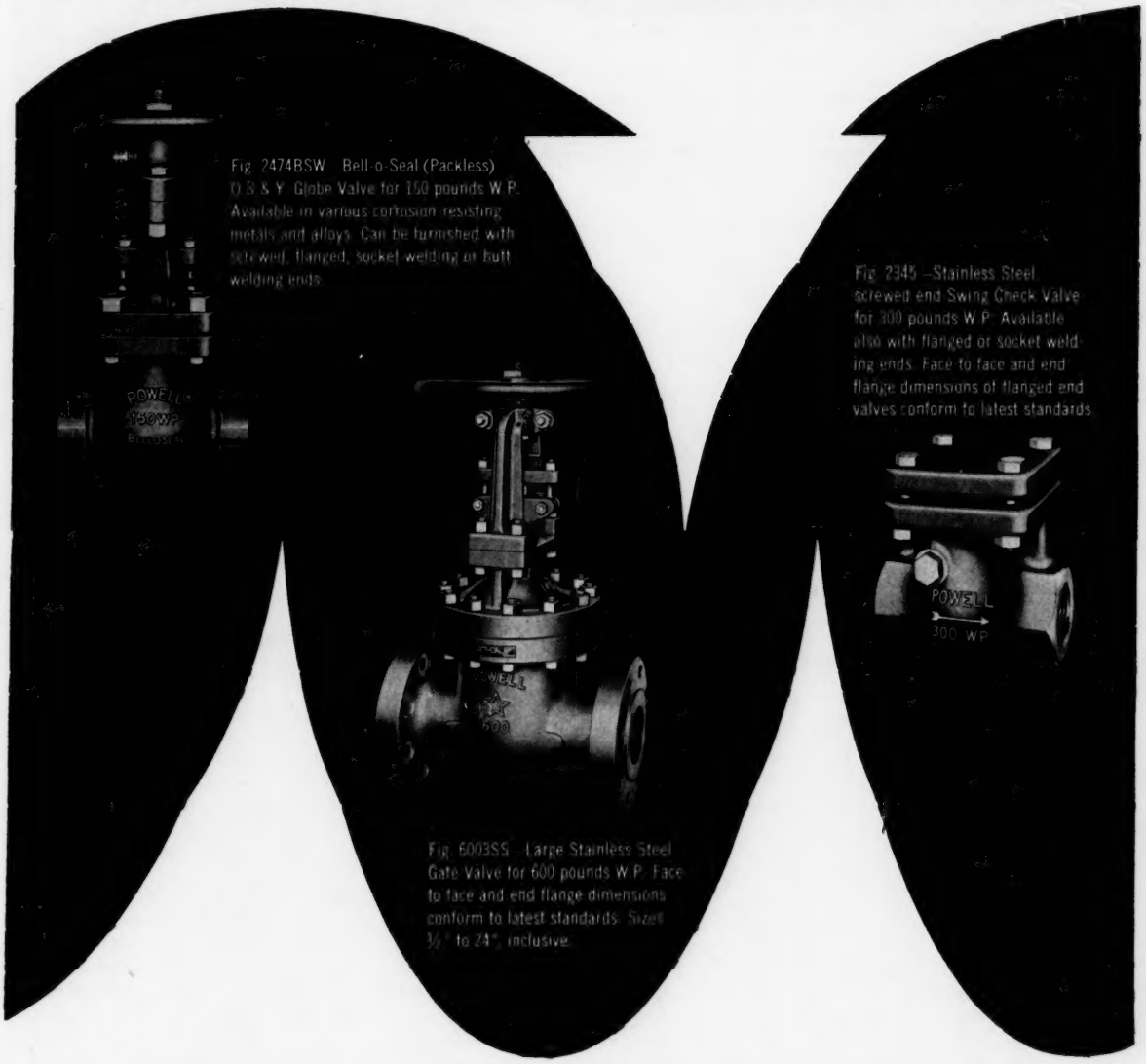


Fig. 2474BSW Bell-o-Seal (Packless) O.S. & Y. Globe Valve for 150 pounds W.P. Available in various corrosion resisting metals and alloys. Can be furnished with screwed, flanged, socket welding or butt welding ends.

Fig. 2345 –Stainless Steel screwed end Swing Check Valve for 300 pounds W.P. Available also with flanged or socket welding ends. Face to face and end flange dimensions of flanged end valves conform to latest standards.

Fig. 6003SS Large Stainless Steel Gate Valve for 600 pounds W.P. Face to face and end flange dimensions conform to latest standards. Sizes 3½" to 24", inclusive.

Powell pure metal and special alloy valves have long been recognized by the Chemical and Process Industries as leaders in the field of corrosion-resistant flow control equipment.

The result of painstaking research; years of experience in modern foundry practice, pattern limitations, and machining possibilities, Powell Corrosion-Resistant valves can be depended upon for long uninterrupted service, with little or no maintenance, and freedom from contamination of end product.

They are available in a wide selection of materials ranging from "A" to "Z" (Aluminum to Zirconium) to handle practically every known corrosive media. For complete details contact your nearby Powell Valve Distributor—or write directly to us.

Powell . . . world's largest family of valves

THE WM. POWELL COMPANY • DEPENDABLE VALVES SINCE 1846 • CINCINNATI 22, OHIO

Typical Container Specification Defines Bag—Fig. 1

Container Specification No. 0000
Product: XYX Date:

MULTIWALL PAPER SHIPPING SACK

Type:	Sewn Valve (SV)
Size:	17" x 4" x 34"
Construction:	To comply with U.F.C. (a) Rule 40, Section 10 (c)
Plies—	2/50, 1/60, 1/90AL, 1/70
Paper—	To conform to the requirements of Federal Specification UU-S-48 of the latest issue.
Glue—	Regular
Tape—	70# Flat Kraft
Thread—	Rayon—1530 denier of approved quality
Filler Cord—	Paper Cord
Printing:	Face and Gussets in (1) Color
Brand—	XYZ
Design—	In accordance with copy and colors shown on page 2 of this specification (b).
Reverse—	(1) In accordance wuth UFC Rule 40, Section 10 (c) (2) Container Specification on No. 0000 (3) 5-290+AL (Ply Marking) (4) Purchase Order No.
Packing:	(b)
Weight:	1210# per 1000 Bags (c)
C/L Quantity:	Approx. 30,000 Bags per minimum C/L (d)
Note:	Please ship two outturn samples of each order to:

(a) Or other applicable agency.

(b) Instructions should be given here regarding how empty bags should be packed depending on handling facilities.

(c) Information available from bag suppliers.

(d) Based on 36,000 minimum carload.

commonly used for different commodities. The list is too long to include in its entirety, so we have reproduced a portion of it in Table II.

A brief study of even the abbreviated list indicates the wide range of constructions for similar products with identical net weights. This merely shows that perhaps the only thing certain in the selection of a M/W bag is individuality. Thus each product, each location and packing method, each set of shipping and handling conditions and many other factors make each problem different from the next one.

We can make a rough estimate, of course, and suggest a construction of 2/50, 2/60 as a starting point, the heavier plies (60 lb. kraft) on the outside.

For the export bag, which should be stronger than the domestic bag, we suggest that a moisture barrier be added to protect against the uncertain weather conditions often encountered in this service. A 90 lb. asphalt laminated barrier (30 lb. kraft/30 lb. asphalt/30 lb. kraft per ream of 500 sheets, size 24 in. by 36 in.) should be adequate. We suggest, then, for our export bag the construction 2/50, 1/60, 1/90AL, 1/70. (Refer to the first article in the May 16 issue for explanation of the symbols 2/50, 2/60, etc.)

Regardless of the construction we choose at first, we should keep a careful record of all shipments for some time to determine whether the strength of the bags should be increased or decreased. If it appears that the bags are too strong, the total basis weight can be reduced gradually.

There are many types of sewn closures available for our export bag, but a simple "tape over sewing" construction, for which there is no extra charge, should be adequate.

We now have enough information so that we can obtain sample bags for filling tests on the actual bagging equipment. This is a most important step. Bags should never be ordered in quantity until it is done because, despite the most careful calculations, some changes are usually required. At least fifty bags should be tested in this manner. Even after using bags for long periods, minor changes in size and construction may be required.

►**Write a Specification** — To avoid the possibility of error when purchasing bags, you should write a specification for each different bag purchased. Fig. 1 is a detailed specification for the export bag we just designed for our fictional product.

Chemical Engineers Prominent in Maintenance

Chemical engineers are prominent in maintenance and plant engineering these days. Though this is particularly true in chemical companies, where you might expect chemical engineers in all functions, it is also true in companies having little or nothing to do with chemicals.

We arrive at these conclusions through observance of attendance at Maintenance Conferences around the country. Most recent of these was the 3rd National Maintenance and Plant Engineering Conference at St. Louis, Mo., April 25-26, given under the auspices of the ASME.

Representatives of chemical companies, though in the minority, were prominent in both the audience and on the rostrum and most of these people were chemical engineers. But chemical engineers were also sprinkled liberally through the ranks of the non-chemical industry representatives.

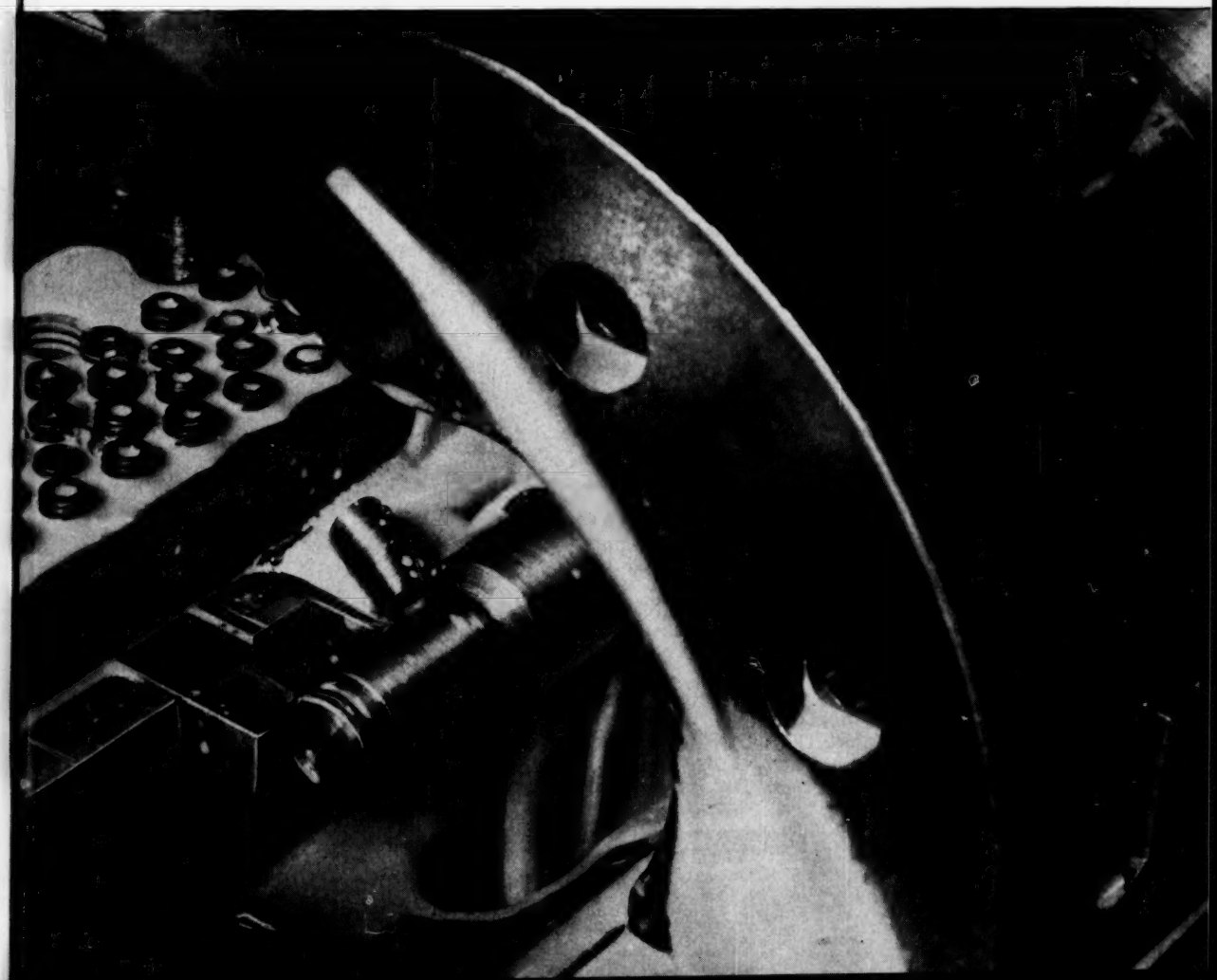
Put dependability in soluble oils . . . with CARBIDE'S Ethanolamines

Take the case of "soluble" cutting oils! CARBIDE's mono- or triethanolamine produce oils that are low in odor, low in corrosive characteristics—and emulsify in water with the simplest stirring. Results? Stable and uniform emulsions. Also, mono- or triethanolamine yield emulsions of such high dispersion and uniformity, that you need use only low concentrations of the oil to get good lubrication.

Other types of profitable "soluble" oils stemming from CARBIDE's ethanolamines, isopropanolamine, or morpholine have special properties that make them particularly useful for lubricating textile machinery and for conditioning rayon fibers before spinning or knitting. You can obtain technical data and starting formulations on "soluble" oils—and oil and solvent emulsions, wax emulsions, oil and wax polishes, cosmetics, and detergents from your CARBIDE Technical Representative. Or, write Department H, Union Carbide Chemicals Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, New York. In Canada: Carbide Chemicals Company, Division of Union Carbide Canada Limited, Montreal.

UNION CARBIDE CHEMICALS COMPANY

UNION CARBIDE



New On-Stream Corrosion Check

Gamma rays and film combine in this novel technique for spotting pipeline corrosion. One big advantage: you can inspect for corrosion while equipment is operating.

A host of instruments are available for measuring metal corrosion, ranging from simple calipers to ultrasonic and radioactive devices. But most have one big disadvantage: equipment has to be shut down for examination.

A novel nondestructive technique, using gamma rays and film, now allows you to check corrosion while equipment is on stream. It permits prefabrication of replacements, pre-shutdown surveys, and spotting of trouble before it brings on an emergency. A particularly useful application: pipeline inspection.

▶ **Canadian Development**—This Sinco Tru Gage method was developed by the Sarnia Inspection Co., Sarnia, Ontario, Canada. It's patented in Canada and patents are pending in this country.*

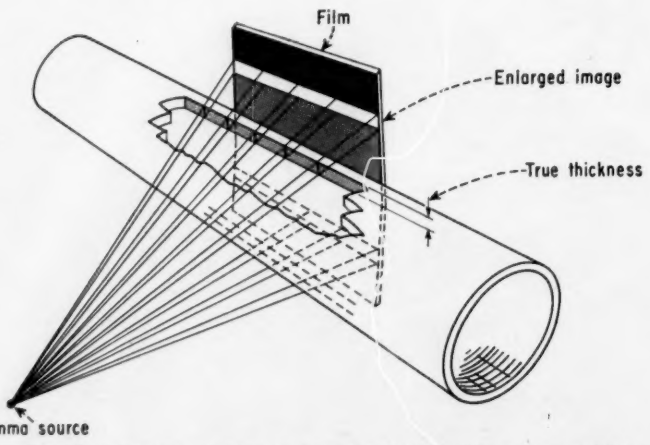
Actually, gamma-rays-and-film is a well-established technique for equipment inspection. But with the Sarnia design, a pipeline or vessel doesn't have to be empty (although density of contents must not be identical to the metal). Also, the gage is not affected by temperature. And it's not necessary to remove insulation in pipe sizes below 8-in.

▶ **Fix Film** — Here's how it works: radiographic film is firmly fixed at a proper angle on one side of a section of pipe. The gamma source is then placed at a predetermined distance on the side opposite the film. Exposure must take account of wall thickness, flow medium and distance from the radiation.

On the exposed film, the area surrounding the pipe is black (*see drawing*). The inside appears in several shades of grey. But the rays traveling through the top and bottom of the pipe have to penetrate the chord of a pipe segment. These two areas, giving a measure of pipe thickness, appear as white areas on the film. Actually, the exact wall thickness can be calculated from data taken off the film. And deposits or buildup show up clearly, as well as pitting, erosion and gouging.

One company in the Sarnia area, used the gage on 145 check points when preparing for their annual plant turnaround. About 80% of the piping involved ranged from 1½ to 6-in. Remainder was 8 to 10-in. Operating temperatures: 500 to 850 F. Except for the larger size pipe, gamma-ray shots were taken without removing the insulation —a major cost-saving item in pipeline inspection.

▶ **Accuracy Check**—Accuracy of the method was checked by interpreting results on corroded pipe—one empty, the other containing liquid. Results were compared with data on the same pipe, after each was dismantled, cut



TRUE WALL thickness of pipe is calculated from film image, which is larger than actual pipe. Fluids in the pipe don't interfere with technique.

* Available in the U. S. from Pittsburgh Testing Laboratory, New Orleans, La.

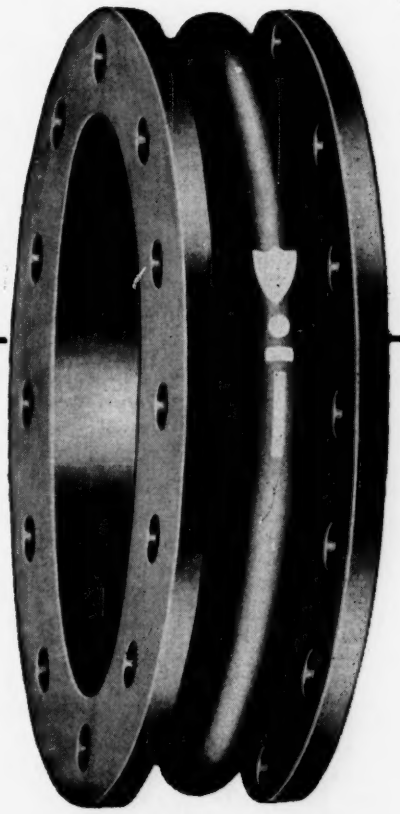
US RUBBER EXPANSION JOINTS

THEY STAY FLEXIBLE
when handling the most severe chemicals

"U.S." Expansion Joints of
butyl rubber construction are recommended
for handling certain chemicals.

Typical of these are:

ANILINE-R.T.
DIETHYL SEBACATE-R.T.
HYDROCHLORIC ACID (37%) UP TO 122° F
SODIUM HYDROXIDE (20-50%) UP TO 158° F
SODIUM HYPOCHLORITE (20%) UP TO 158° F
SULFURIC ACID (50%) AT R.T.



"U.S." Expansion Joints remain completely flexible at all times. Joints made of neoprene or natural rubber stiffen up, crack and fail when handling the above chemicals.

For the most severe service, specify "U.S." Expansion Joints lined with Teflon. These "U. S." Joints are ideal for handling most chemicals and solvents.

"U.S." Expansion Joints are in use in every kind of industry. Some of these joints have been on the job since 1924, the year "U.S." invented them! Long-lived, they *prolong the life* of equipment in pressure and vacuum systems.

• • •

When you think of rubber, think of your "U.S." Distributor. He's your best on-the-spot source of technical aid, quick delivery, and quality industrial rubber products.

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WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS
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and gaged with a micrometer. Variances between micrometer and film readings were in the order of one thousandths of an inch.

While primarily a pipeline corrosion instrument, the gage has been used to spot clogged and plugged areas. And in one case, it helped pinpoint the reasons behind a malfunctioning relief valve. Film was exposed while the valve was in operation, and analysis showed that lifting fingers were not reaching the valve lifting flange—the fingers were jamming against a bolt.

There are, of course, some limitations to this technique. Trying to get a specific exposure in a crowded process area is no easy trick. Also plate or flat material can't be handled at all. And carefully trained operators together with skilled film analysts are absolutely essential.

Polyethylene Noses Out Steel in Gas Pipeline

High-density polyethylene pipe can easily compete with steel in buried, low-pressure, gas pipeline systems.

At least this is the claim of Phillips Chemical, Bartlesville, Okla., a major producer of the plastic, whose parent company, Phillips Petroleum, installed over 60 mi. of 2 to 8-in. dia. polyethylene pipe in natural gas fields in 1959.

Actually, for 40 to 80-psi. service, high-density polyethylene can be installed for less money than coated and wrapped steel (*see table*).

Also taking sharp aim on this market is aluminum (*Chem. Eng.*, Nov. 2, 1959, p. 122), where costs are within 4% of steel.

Polyethylene, similar to aluminum, needs no coating or wrapping, since no known corrosive soils attack the plastic, and there's no need for cathodic protection.

▶ **Butt Fusion** — Phillips' Leo Croley, reporting on this development at a recent Permian Basin Regional meeting of the National Gasoline Assn. of America, described a butt-fusion joining technique for the pipe, which is simple, fast, cheap and gives a strong joint. Phillips has developed semi-automatic equipment which eliminates much of the hand labor usually involved in joining thermoplastic plastic pipe.*

One unit joins 2, 3, and 4-in. diameters. A larger, more automatic unit, handles 2, 4, 6 and 8-in. sizes.

A major function of this equipment is to provide line-up clamps. The larger unit, mounted on wheels, comes equipped with an inline facer which simultaneously squares both ends of the pipe. A portable generator provides electric power for the facer and a heating plate. The smaller unit comes with a separate device for facing.

▶ **Plate Heating** — Technique then calls for pressing squared pipe ends against an electrically heated aluminum plate. This is at 380-410 F., under thermostatic control.

Pipe ends remain against the plate until a ⅛-in. dia. bead forms and rolls back from the plate. Then pipe ends are pulled away, the plate removed and the ends gently pressed together. After ½ min. of cooling (4 to 6-in. dia.), the pipe joint is ready for service. Usually, such a joint is stronger than the plastic pipe itself.

It takes about 2 to 2½ min. over-all, to make a joint in 4 or 6-in. pipe.

▶ **And Ditching**—Ditch burying is handled about the same way as steel, with field joining along the side of the ditch. Pipe is simply shoved into the ditch. Where backfill is rocky, a soft dirt padding should first go over the pipe.

Either air or water is suitable for pressure testing, with test pressure about twice normal working pressure. A soap solution will show joint leakage.

Using the joining machine and ditch burying, Phillips claims two men can easily lay more than a mile of pipe (6-in., 40-ft. lengths) in 8 hr., assuming reasonable terrain.

To save ditching and backfilling on one installation, high-density polyethylene was used where existing steel lines were badly corroded. Some 4-in.-dia. plastic pipe was joined and pushed inside 8-in. steel pipe. Lines as long as 1,500 ft. have been handled this way.

*Fusion joining equipment is available for purchase or rental at P & S Engineering Co., Bartlesville, Okla.

Corrosion Forum continues on page 126.

How Steel and Polyethylene Compare: $/Ft. for 3-In. Pipe

	Pipe Cost	Install, Including Weld	Install, Excluding Weld	Weld	Coat	Cathodic Protection	Total Installed Costs
Steel							
0.125-in. wall	0.54	0.25	....	....	0.05	0.05	0.89
0.134-in. wall	0.59	0.25	....	....	0.05	0.05	0.94
0.141-in. wall	0.65	0.25	....	....	0.05	0.05	1.00
0.156-in. wall	0.66	0.25	....	....	0.05	0.05	1.01
Sch 40	0.76	0.25	....	....	0.05	0.05	1.11
High-Density Polyethylene, Sch. 40	0.69	....	0.13	0.02	....	....	0.84

*Does not include engineering overhead (right-of-way, survey, etc.).

Which of these 3 products and services can yo

New Cold Caustic Bleach Process

Looking for a way to use greater amounts of low-cost, more plentiful pulp—without capital investment for bleach equipment? Then let a Becco Sales Engineer show you our new technique* which allows you to bleach in the same equipment regularly used for the manufacture of cold caustic pulp.

In this new process, peroxide bleach liquor is added at the Bauer Refiner, and bleaching occurs during the refining operation. Bleach response depends on refiner densities.

Up to 20 points brightness increase has been obtained in commercial operations to date, and with no additional steam costs, no holding time, and no excessive chemical costs.

Becco can assist you immediately in setting up a production run and evaluating results. First step: use the coupon to let us know you're interested.

*—Patent Pending

BECCO fmc

BECCO CHEMICAL DIVISION, FMC
Station B, Buffalo, New York
Dept. CE-H

Gentlemen:
Please have a Sales Engineer give me more information on Becco's Cold Caustic Bleach Process.

NAME_____
FIRM_____
ADDRESS_____
CITY_____
ZONE____ STATE_____

"Enclosing $1.00 — Send Patent License"

Well, perhaps there's a little more to your gaining use of Becco patents than just mailing your dollar in, but not much more. And certainly, no more money. The $1.00 really does cover it.

Becco has lots of patents, granted as a result of innovations in the use of Hydrogen Peroxide and other Peroxygen chemicals developed in Becco's Research Laboratories. But they don't do us a whole lot of good locked tightly in our safe. So, we long ago adopted the following policy:

If one of our patents can help you, we'll be glad to license the rights to you **perpetually,** for just one dollar. You get a nice certificate, incidentally, to cover the legalities, but more important — you also get free our complete engineering help in setting up your process, handling the material, maintenance, etc., etc.

What do **we** get? You as a **customer** — we hope — but there's no obligation on your part. Just seems to work out that way, though — when we know enough about a particular peroxygen to hold a patent on its use, chances are we've also learned enough to produce it purer than anyone else. You benefit from this; we do, too.

Use the coupon below to ask for a Sales Engineer — or our list of patents — that may help you solve an important problem.

BECCO fmc

BECCO CHEMICAL DIVISION, FMC
Station B, Buffalo, New York
Dept. CE-F

Gentlemen:
Please send your list of patents available on the use of
- ☐ Hydrogen Peroxide
- ☐ Peroxygen Chemicals
- ☐ Persulfate Chemicals
- ☐ Please have a Sales Engineer call.

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Problems in handling Hydrogen Peroxide

Becco's Four-Fold Engineering Service Program—offered free—includes:

1. Comprehensive survey of your facilities.
2. Specific proposal with recommendation of proved equipment and where it is obtainable.
3. Installation supervision by Becco.
4. Periodic inspection and permanent service.

Can you use this free Becco help, based on more years of experience with bulk handling of H_2O_2 than any other manufacturer? Use the coupon to let us know.

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Gentlemen:
Please tell me more about your Four-Fold Engineering Service.

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Tantalum Touted for Low-Temperature Service

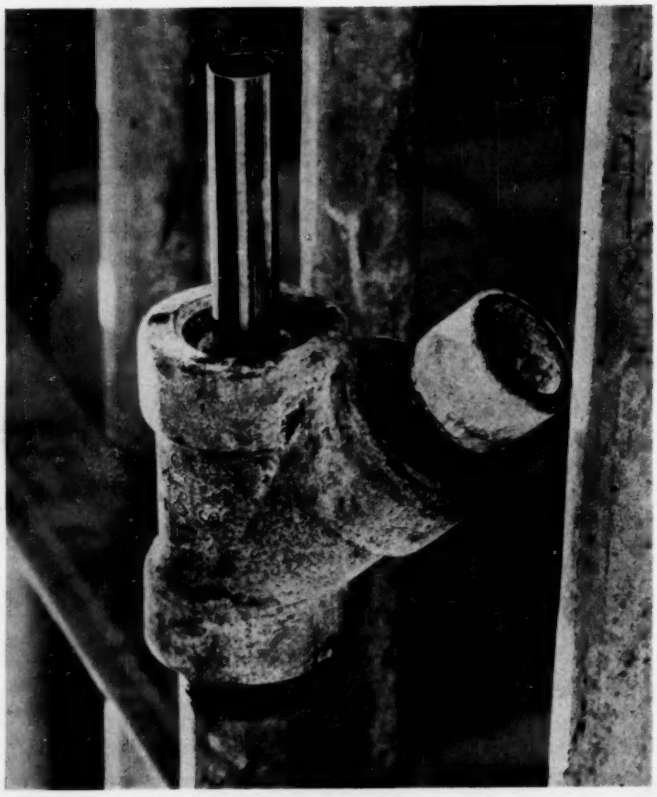
Known primarily for its excellent high-temperature (2,000 F.) properties, tantalum also looks good at the other end of the temperature scale (−321 F.).

This comes from a study by M. Schussler of Union Carbide Metals and J. S. Brunhouse of Aerojet-General Nucleonics. They find wrought tantalum, consolidated by arc-melting or electron-beam melting, has good strength, reasonably good tensile ductility and excellent notch toughness at liquid-nitrogen temperatures.

Other results of their study include:

- For short-time temperature service up to 2,000 F., there is a very large strength advantage, with good ductility, in arc-melted tantalum over electron-beam material. Also the arc-produced metal can be more easily cold worked to increase strength. There are moderate concentrations of interstitials in arc-melted Ta — electron-beam material has a higher purity.
- Forming characteristics on electron-beam metal are somewhat better than some annealed aluminum alloys or brasses. Arc-melted tantalum is a little more difficult to form than annealed low-carbon steel.
- With identical compositions and microstructures, the mechanical properties should be very similar for both melted and vacuum-sintered tantalum.

Tantalum usage is increasing rapidly in chemical processing equipment, because of outstanding corrosion resistance to both oxidizing and reducing chemicals; in the medical field, because of its inertness; and in the electronics field because of special capabilities in capacitors.



Titanium Tubing Makes Good in Hypochlorite Plant

The strange-looking object above is actually a section of a heat exchanger—titanium tubing inside galvanized-steel pipe. Kuehne Chemical Co., Elizabeth, N. J., went to this design for handling a particularly tough chemical; hot, corrosive, sodium hypochlorite. It enters at about 97 F., exits at close to cooling-water temperature.

Tubing is ¼-in. O.D. with a 0.028-in. wall (Republic Steel's RS-55). Steel jacket is 1-in. I.P.S., providing a space of less than ¼-in. between jacket wall and tubing.

Entire system is composed of 24 lengths of tubing, each 30-ft. long, arranged in three groups of four each in series; two groups of six each in parallel.

Clad Metal Made by New Extrusion Technique

Four years of development work at Battelle has produced a unique new process: metal cladding by extrusion.

A. M. Hall, chief of Battelle's alloy development division, sees good possibilities for this technique in making heat-exchanger tubing.

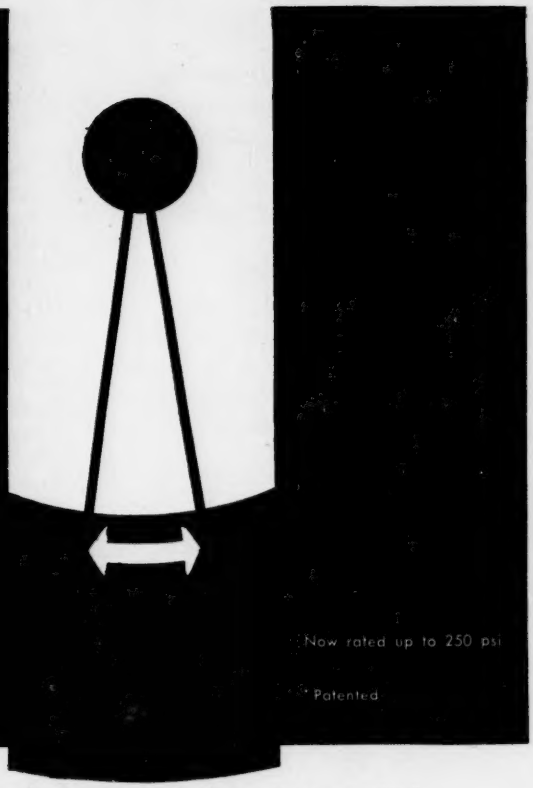
Older methods involve rolling cladding metal over a rod or tube acting as the core. The new extrusion process calls for feeding core material through a hollow mandrel. This material then meets cladding metal and both pass through a die which governs the cladding shape.

Three advantages come from this extrusion: (1) close dimensional control, (2) strong bond between core and cladding, (3) cladding doesn't have to take the same contour as the core. At least these are the advantages Battelle has found when working mainly with aluminum-clad steel.

MULTI-ZONE

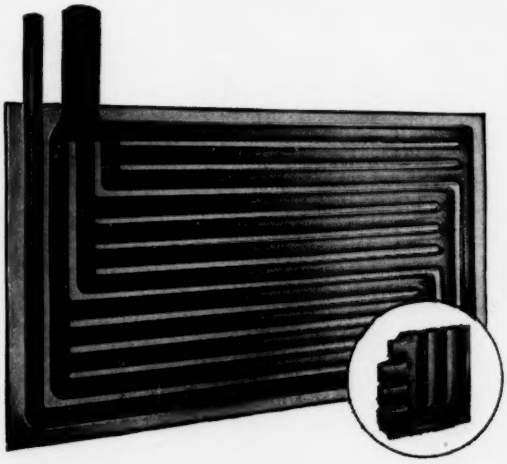
PLATECOIL®

FASTER START-UP, CONSTANT TEMPERATURES



The new MULTI-ZONE design cuts "downtime" and compensates for intermittent overload in a wide range of tank and process heating applications. Multiple headers and multiple condensate returns provide for FREE-FLO action — with practically instantaneous distribution of steam to all levels of the plate. Condensate "trapping" is held to a minimum. This gives the new MULTI-ZONE PLATECOIL a reserve capacity to deliver under overload conditions during "start-up." It also produces extremely fast recovery of tank temperature with minimum variation.

IN ALL KINDS OF TANK AND PROCESS HEATING



Operating Pressures up to 250 psi — DURAWELD bonding of the plates and mill-controlled TRANSTEEL in standard units have boosted PLATECOIL pressure containment rating up to 250 psi. This makes the time-proven advantages of PLATECOIL applicable to many types of heating where 250 lb. steam is required. Destruction tests have demonstrated a safety factor of 5 to 1.

Low Installation and Maintenance Costs. — PLATECOIL costs are low compared to the cost of engineering, fabricating, installing and maintaining pipe coils. Lightweight, compact PLATECOIL simplify installation. Greater heat transfer per sq. ft. of surface permits smaller units which save valuable tank space. Streamlined surfaces cut cleaning costs. Integral, factory fabricated construction eliminates threaded joints (in the solution) to corrode or leak. All stainless steel and alloy PLATECOIL units affected by cold working are annealed and pickled after fabrication to return the metal to its original condition and thus eliminate the probability of corrosion due to internal stresses and carbide precipitation.

Write for NEW PLATECOIL Bulletin P61 for more data.

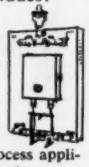
Tranter Manufacturing, Inc.
LANSING 9, MICHIGAN

PLATECOIL® DIVISION

WILLIAM C. DIMAN,
Atmosphere Equipment Specialist, reports . . .

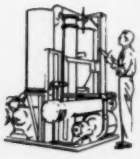
MODERN PROCESSES DEMAND MODERN ATMOSPHERES

Ever since 1927, when C. I. Hayes perfected the first controlled-atmosphere heat treating furnace, we have made a steady effort to further the technology of atmosphere generators and dryers. By recommending proper generators and dryers, we have helped our customers speed production, improve product uniformity and quality and save processing time and trouble. The big Hayes equipment line includes:



MOLECU-DRYER (using LINDE'S Molecular Sieves) — for drying, sweetening, purifying protective atmospheres and for gas and liquid separation and recovery. Exit gas dew points to less than minus 100°F. Many standard sizes available for process applications, instrument air drying, etc.

Linde MOLECULAR SIEVES



NITROGEN GENERATORS (using LINDE'S Molecular Sieves) — produces 99.99% pure inert gas at about 20¢ per 1000 cu. ft. Standard sizes from 1000 CFH to 10,000 CFH.

"ENGINEERED ATMOSPHERES" — HAYES offers a broad range of equipment for producing oxidizing, reducing, carbon-potential, and nitrogen-hydrogen atmospheres . . . also engineered equipment packages for stand-by (start-ups, emergencies, etc.). Standard sizes are available in all types: Exothermic, Endothermic, and forming gas generators — also ammonia dissociators.

Hayes offers more than just equipment. Our Engineering organization and experimental lab. are ready to help make sure you get the right atmosphere equipment for your work.

ASK FOR BULLETINS . . .	Bulletin No.
Molecu-Dryer	5703-A
Nitrogen Generator	5901-NI
Exothermic Generator	256-A
Endothermic Generator	5808-A
Ammonia Dissociator	5810-D
General Bulletin	5810-GC
Forming Gas Generator	256-A

C. I. HAYES, INC.
Established 1905
843 WELLINGTON AVE., CRANSTON 10, R. I.

It pays to see Hayes for metallurgical guidance, lab facilities, furnaces, atmos. generators, gas/liquid dryers.

INDUSTRY NEWS . . .

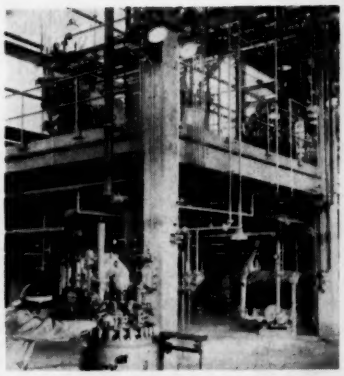
(*Continued from page* 52)

plants: tire manufacturing plants at Calgary, Canada, and Bethune, France; and synthetic rubber plants at Port Jerome, France, Bareilly, India, and Orange, Tex.

Mid-America Pipeline Co. is constructing a $71-million pipeline to carry LPG products from Texas and New Mexico to the St. Paul and Milwaukee areas. Company expects to complete the 1,800-mi. line late this year. Ultimate combined capacity to the two northern terminals will be 83,000 bbl./day.

Cary Chemicals Inc. has completed expansion of a plant at Flemington, N. J., which produces PVC homopolymer and copolymer resins. The reactor above is one of six installed during expansion, giving a new capacity of over 50 million lb./yr. A new pilot plant building is among the other facilities added. Cary has also expanded its compounding facilities at East Brunswick, N. J.

American Oil Co. plans a large-scale capital improvement and modernization program for its refinery at Texas City, Tex. Three new major units are included: a 150,000 bbl./day crude unit, which will be largest in the world; a catalytic cracking unit with fresh feed rate around 47,600 bbl./day; and a 14,600 bbl./day alkylation unit, which will also be the largest of its kind. The new equipment will replace existing units and will add slightly to refinery's current crude capacity of 160,000 bbl./stream day.

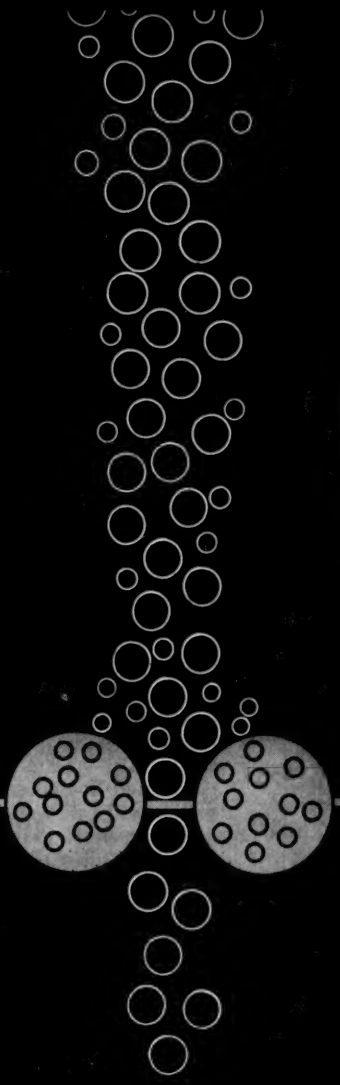


Union Carbide Corp. has erected this new process development building at its plant in Long Reach, W. Va. The three-story structure is equipped for a variety of operations, and its use replaces Carbide's process development activities at Tonawanda, N. Y.

Dixon Chemical Industries, Inc., has signed construction contracts for a $3.5 million hydrofluoric acid plant, to be built at Paulsboro, N. J. The 11,000-ton/yr. plant will use the Swiss-developed Buss process, said to insure high-quality acid while incurring low maintenance costs. Plant completion is scheduled for early 1961. (See also CE, Jan. 25, 1960, p. 45.)

Allied Chemical Corp.'s General Chemical Division has announced plans to build a phosphoric acid plant at its East St. Louis, Ill., works. The new plant, with projected capacity of 50,000 tons/yr. of wet process acid, is scheduled for production early in 1961.

St. Paul Ammonia Products Inc. proposes to spend 4 to 8 million dollars on expansion of its nitrogen plant at Pine Bend, Minn. This announcement follows a $1.5-million expansion of last year, and the proposed move would



One-stage purification delivers

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This is only one of many applications which utilize the high capacity and selectivity of LINDE Molecular Sieves. In fact, Molecular Sieves not only outperform other adsorbents, but do other adsorption jobs never before accomplished. Whether in new installations or as replacement adsorbent in existing units, Molecular Sieves can help you minimize both investment and operating costs. More specifically, here's how they are used. . . .

A major petrochemical company has reduced the CO_2 content of its ethylene from 3000 PPM to less than 1PPM. This high purity is achieved in a single-stage process, automatic and non-corrosive, which has proved to be more economical than the alternative four-stage process. Other petrochemical uses include drying of cracked gases, ethylene, hydrogen, liquid propylene, solvents and many other gases and liquids. **Natural gas producers** use Molecular Sieves for drying and sweetening of natural gas, for sweetening of liquid propane and butane, and for drying of adsorber oil. **Petroleum refiners** use them to gain efficiency in drying reformer hydrogen, liquid butane LPG and transformer oil, and for removal of impurities such as CO_2 and mercaptans. **Refrigeration manufacturers** use Molecular Sieves as a desiccant in super-drying refrigerants to eliminate freeze-up and corrosion.

For these and many other adsorbent applications, you can rely on patented LINDE Molecular Sieves to perform more effectively. They are the top quality material of their kind available today, always uniform, with high capacity, high strength, and high bulk density. They are available in regular and special grades to meet your specifications.

LINDE technical know-how—gained from years of laboratory and field work with adsorption problems—can help make Molecular Sieves work profitably for you. For further information, write: Dept. CE-055 Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York. **In Canada:** Linde Company, Division of Union Carbide Canada Limited, Toronto 7, Canada.

SOME AREAS WHERE MOLECULAR SIEVES IMPROVE ADSORPTION

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- Drying gases, liquids, solvents
- Drying, sweetening natural gas
- Sweetening liquid propane, butane
- Drying jet fuels
- Octane improvement
- As refrigerant desiccant
- Controlled atmosphere purification

LINDE COMPANY

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Newest plastic pump design! Molded from Penton* for widest possible corrosion resistant service even at elevated temperatures. Safely handles corrosive chemicals such as concentrated sulphuric acid, concentrated chlorine solutions, ferro-cyanide bleach and concentrated sodium hydroxide. Features high operating efficiencies, excellent balance, low maintenance.

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For long, trouble-free pump life check Chemtrol. Ask for operating data, chemical resistances, prices. For recommendations send operating requirements.

SPECIFICATIONS: Chemtrol "Alpha Series" Pumps

Availability: Close coupled, immediately; pedestal mount to follow.
Size: 1" outlet x 1¼" IPS inlet.
Materials: Body, impeller and seal housing in Penton.*
Shaft Seals: Mechanical with Teflon seal rotating against stationary ceramic sleeve.
Motors: ¼ to 2 h.p.; 1750 to 3500 r.p.m. Drip proof, fully enclosed or explosion proof.
Impellers: Enclosed type with optimum contour design. Open type for special service.

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404 West Central Avenue • Santa Ana, California

boost ammonia capacity to 110,000 tons/yr.

El Paso Natural Gas Co. has awarded Fluor Corp. a contract of over $3 million to build a natural gas treating plant near Sheffield, Tex. Plant will process 220 million cu. ft./day of sour gas, containing as much as 53% CO_2, using a new Fluor-developed process (see CE, Mar. 7, 1960, p. 53). Plant is to be on stream in December of this year.

Continental Oil Co. has announced start of construction on the world's second Hydrar unit, for conversion of benzene into high-purity cyclohexane. The UOP-process plant will be located at Ponca City, Okla., and is due to be completed in September. Capacity will be 20 million gal./yr. of product. (First Hydrar unit: at Gulf Oil's Port Arthur, Tex., refinery.)

Cities Service Co. announces that it will build a multimillion-dollar petrochemical plant, to be located at Cities Service Refining Corp.'s refinery at Lake Charles, La. Plant will use existing units as raw material source to make ortho-xylene, with an annual capacity of 120 million lb.

Kaiser Industries Corp.'s Refractories and Chemicals Division has a new plant on stream at Midland, Mich., producing refractory raw materials. Capacity of the $3-million plant is 45,000 tons/yr. Main product is periclase, a crystalline hard-burned magnesia.

Dow Chemical Co. has announced startup of two new polyethylene film plants. One is at Fresno, Calif.; the other is at Findlay, Ohio.

Minneapolis-Honeywell Regulator Co. announces that facilities of its Brown Instruments Division for making thermocouples and other pyrometer supplies have been expanded. Operations in Philadelphia

have been streamlined, and a new plant is operating in Los Angeles.

Food Machinery and Chemicals Corp. will begin construction on a new Research and Engineering Center around July 1, to be located at Santa Clara, Calif.

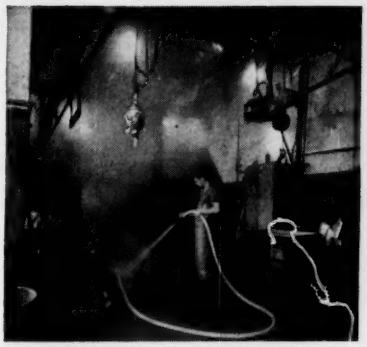
The Glidden Co. plans to build a $2-million paint plant at Dallas, Tex. Initial capacity will be up to 200,000 gal./mo. Construction will be started within four or five months.

Minerals & Chemicals-Philipp Bros., Inc., will be the name of a new, merged corporation if stockholders of the companies involved — Minerals & Chemicals Corp. of America, Philipp Bros., Inc., and Philipp Bros. Ore Corp.—agree to the proposed merger. Directors of the three companies are in favor of the move. The new corporation would operate in the ferrous and nonferrous metals and ore field, and also in the chemical area.

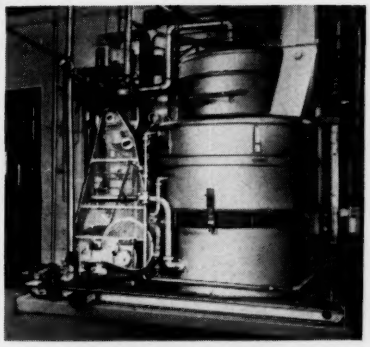
High Pressure Associates is the name selected for an advisory group on high-pressure technology which was established last fall. Chairmanned at present by B. F. Dodge of Yale University's chemical engineering faculty, the group is to consist of interested scientists and engineers having experience in high-pressure techniques. Functions envisioned for the group include consultation, establishing operational standards, and preparing a handbook of safety measures.

Allis-Chalmers Mfg. Co. has appointed Brice Machinery & Controls Co. of Houston as sales representative for A-C's industrial machinery and control equipment.

3 BOILERS IN 1 COMPACT PACKAGE!



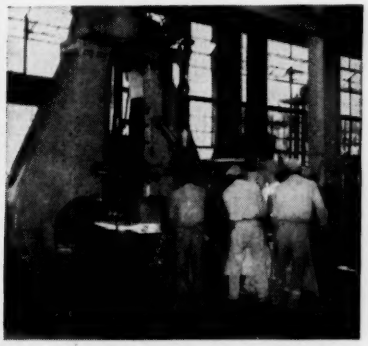
FOR ORDINARY STEAM REQUIREMENTS: The cycle-type Modulātic standard unit furnishes 90% dry steam for most ordinary needs such as cooking, heating water, drying, cleaning, etc.



WHERE DRY STEAM IS REQUIRED: The Modulātic may be used with an optional steam separator, for over 99% dry steam for heating, moulding, forges, operation of power equipment, etc.

VAPOR MODULĀTIC WATER TUBE BOILERS

¼ the size and weight of conventional boilers... largest size (150 BHP) uses only 5′ x 8′ space.



IF CONSTANT STEAM LOAD MUST BE MAINTAINED: For applications where even a nominal drop in pressure cannot be allowed, an optional steam reservoir may be added to the standard unit to provide a "cushion" during an off cycle.

Efficient... economical... proved in thousands of installations all over the world! Vapor Modulātics furnish high or low-pressure steam (at design pressures up to 1000 psi, or even higher). Lowest installation costs—delivered completely assembled, wired and tested . . . all sizes (40 to 150 BHP) fit through plant doors, with no special foundations or special chimneys needed. Simple push-button operation; built-in safety controls. May be mounted in multiple units to provide for the largest steam requirements—without the inefficiency of idling larger single boilers as demand slackens.

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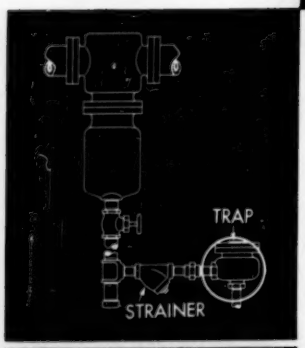
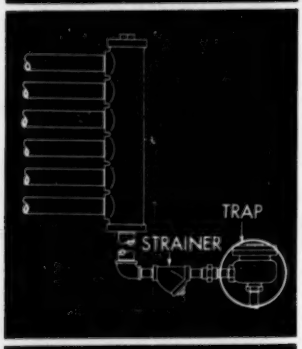
Our requirements are:

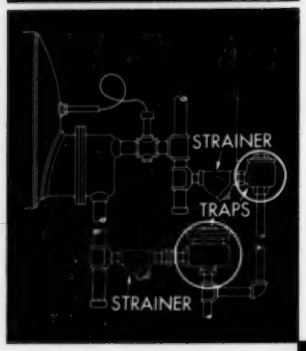
BHP REQUIRED_____
SAFETY VALVE SETTING_____
MINIMUM STEAM LOAD_____
MAX. STEAM LOAD_____
STEAM PRESSURE_____
TYPE OF FUEL_____

sure . . .

steam traps are a mere fraction of total steam equipment cost, but . . .







. . . what about your TOTAL thermal efficiency?

When you aren't getting top efficiency from your equipment . . . when leaking, dribbling steam waste lessens its full usefulness . . . when air or other non-condensables cause trouble . . . where do you look? Your steam traps! That's why it's mighty important that they (1) fully discharge condensate, air and other non-condensables promptly and (2) give long trouble-free service. Nicholson traps meet the first requirement because they operate on a *true balanced pressure* principle . . . and the second, because they only have one moving part, thus reducing the possibility of down-time. Other advantages are positive shut-off . . . high capacity . . . rigid pretesting.

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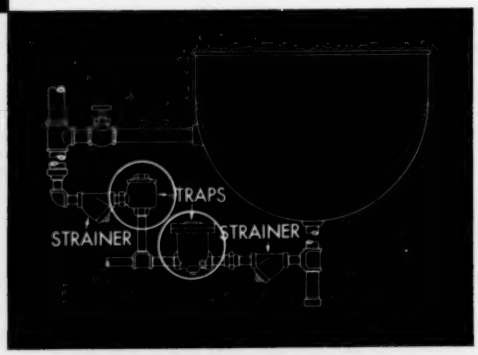

CALENDAR

Instrument Society of America, Instrumental Analysis Symposium.
June 1-3 Montreal, Ont.

Vacuum Metallurgy Conference, New York University Engineering School.
June 2-3 New York, N. Y.

American Society of Mechanical Engineers, semi-annual meeting, Statler-Hilton Hotel.
June 5-9 Dallas, Tex.

Society of Plastics Industry, annual plastics exposition, Coliseum.
June 5-9 New York, N. Y.

National Society of Professional Engineers, annual meeting, Statler-Hilton Hotel.
June 9-11 Boston, Mass.
White Sulpher Springs, W. Va.

Manufacturing Chemists Assn., annual meeting, The Greenbrier.
June 9-11

Society of Women Engineers, 10th annual convention, Benjamin Franklin Hotel.
June 9-12 Seattle, Wash.

Achema congress and exposition of chemical engineering.
June 9-17
Frankfurt am Main, W. Germ.

American Nuclear Society, national meeting, Palmer House.
June 12-15 Chicago, Ill.

Industrial Pharmaceutical Research Conference: Stabilization of Pharmaceutical Chemicals; King's Gateway.
June 12-15 Land O'Lakes, Wis.

International Powder Metallurgy Conference, sponsored by American Institute of Mining, Metallurgical and Petroleum Engineers, Hotel Biltmore.
June 13-15 New York, N. Y.

American Assn. of Cost Engineers, annual meeting, Rice Hotel.
June 13-15 Houston, Tex.

Chemical Institute of Canada, annual conference and exhibition, Chateau Laurier.
June 13-15 Ottawa, Ont.

Rochester Institute of Technology, 17th annual Statistical Quality Control Programs for the Chemical and Processing Industries.
June 13-22 Rochester, N. Y.

Technical Assn. of the Pulp and Paper Industry, Pulp Bleaching Conference, Edgewater Beach Hotel.
June 14-16 Chicago, Ill.

Dechema, annual meeting and exhibition.
June 14-16
Frankfurt am Main, W. Germ.

Heat Transfer and Fluid Mechanics Institute, Stanford University.
June 15-17 Palo Alto, Calif.

Gordon Research Conference: Chemistry of Coal, New Hampton School.
June 15-17 New Hampton, N. H.

Recent Economic Growth — The Numbers Game

If it truly portrayed recent rates of economic growth in the United States, the report on employment, growth and price levels recently issued by the staff of the Joint (Congressional) Economic Committee would point up scarcely less than a national disaster. Among other things, it would document impressively Premier Khrushchev's crack that "the capitalist steed the United States is riding . . . is worn out."

One of the major findings of the Joint Committee's staff (in the Eckstein Report, named for its staff director Otto Eckstein) is that between 1953 and 1959 the average rate of growth of physical output in the United States was only 2.4 per cent per year. This is scarcely more than half the average annual rate of growth of 4.6 per cent the staff found to have prevailed between 1947 and 1953.

Happily, however, the report does not reflect the basic economic realities. Its finding on relative rates of economic growth for the two periods is a statistical *tour de force* which, by the selection of certain figures and certain dates, distorts the record of America's long-term economic growth.

Playing The Numbers Game

By the selection of appropriate starting and terminal periods it is possible to document almost any rate of economic growth that is desired. The table at the bottom of this page shows you how this can be done. It will also show you how the Eckstein staff worked out its shocking contrast in growth rates. The table is built like a schedule of airplane fares between different cities. The postwar years 1946 through 1959 are put down on two axes. One runs down the left hand column, the other runs across the top of the table. Put your finger on the point where the two axes intersect and you have the average rate of growth for the period covered.

ANNUAL AVERAGE GROWTH RATES OF THE U.S. ECONOMY, 1946-1959*

(Percent increases, starting year to terminal year, of GNP in 1954 dollars).

Starting Year \ Terminal Year	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
1946	X	–0.1	–1.9	–1.2	3.0	3.9	3.8	3.9	3.2	3.7	3.6	3.4	2.9	3.2
1947	X	X	3.8	1.8	4.1	4.9	4.6	4.6	3.7	4.2	4.0	3.8	3.2	3.5
1948	X	X	X	–0.1	4.2	5.3	4.8	4.7	3.6	4.3	4.0	3.8	3.1	3.4
1949	X	X	X	X	8.7	8.1	6.5	6.0	4.4	5.0	4.6	4.2	3.5	3.8
1950	X	X	X	X	X	7.4	5.4	5.1	3.4	4.3	3.9	3.6	2.9	3.3
1951	X	X	X	X	X	X	3.4	3.9	2.0	3.5	3.2	3.0	2.2	2.8
1952	X	X	X	X	X	X	X	4.4	1.3	3.6	3.2	2.9	2.0	2.6
1953	X	X	X	X	X	X	X	X	–1.6	3.2	2.8	2.6	1.6	2.4
1954	X	X	X	X	X	X	X	X	X	8.1	5.1	4.0	2.4	3.2
1955	X	X	X	X	X	X	X	X	X	X	2.1	2.0	0.5	2.0
1956	X	X	X	X	X	X	X	X	X	X	X	1.8	–0.2	2.0
1957	X	X	X	X	X	X	X	X	X	X	X	X	–2.3	2.0
1958	X	X	X	X	X	X	X	X	X	X	X	X	X	7.0
1959														

*Compound rates of growth

Following this procedure, you can find growth rates ranging all the way from −2.3 per cent, between 1957 and 1958, to +8.7 per cent, between 1949 and 1950, along with almost any other rate you would choose for various years and sequences of several years over the postwar period.

For example, if you want to demonstrate that the postwar growth rate through 1953 was less than 4% per year, you take off from 1946, include a drop of 0.1 per cent between 1946 and 1947, and come up with a growth rate for the 1946-1953 period of 3.9 per cent. But if you want to show it was quite high, you take off a year later, from 1947 (which drops out that dismal −0.1 per cent for 1947) and come up with a fine growth rate of 4.6 per cent for the 1947-1953 years.

Statistical Hocus-Pocus

That's what the Eckstein staff did. It took off at one end from a year when there was just about no growth, went to the Korean War boom year of 1953 at the other end, and got that average growth rate of 4.6 per cent. Then it took off from the Korean War boom year of 1953 and ran to the year 1959, when business was recovering from a recession and suffered through a steel strike of 116 days, to come up with its 2.4 per cent growth rate for the second postwar period. As the table indicates, by taking off a year later (1954) the average growth rate would have become 3.2 per cent, and if the take off had been 1949 it would have been 3.8 per cent.

There are those who, in nontechnical terms, would characterize this as statistical hocus-pocus. There are also those who would see in it an element of political hocus-pocus, too. This is because the years 1947-53, when the Eckstein staff found there had been the healthy 4.6 per cent growth rate, were roughly years when we had a Democratic president, while the anemic growth rate of 2.4 per cent it calculated for the subsequent years was for years of a Republican presidency.

Actually it can be shown that the civilian part of our economy has had more rapid growth during the Republican administration than it had during the Democratic years. If military expenditures are subtracted from the national ouput, the resulting growth rate for 1953 to 1959 is slightly higher than for 1947 to 1953.

However, we do not question the *bona fides* of the Eckstein staff. **But we do assert that it has produced a statistical picture of the postwar growth of the American economy which is dangerously misleading both at home and abroad.**

Abroad, the report appears to give official documentation to the propaganda line that the Soviet economy is running rings around the U.S. economy in growth, and that it is Communism a country should choose if it really wants to develop rapidly. Building on a much smaller economic base than the U.S.A., the Soviet Union — as well as almost every less advanced nation in the world — is bound to show a larger percentage increase in output than the U.S.A. But the Eckstein staff calculation gives the Communists ammunition they don't deserve.

Are We Facing A Crisis?

The contrast drawn by the Joint Committee staff in postwar U.S. growth rates suggests that we are facing scarcely less than a crisis through paralysis of our economic growth which calls for drastic remedies. But this, as the full 1947 to 1959 growth record set forth in the table makes clear, is very definitely not the case. Our over-all postwar rate of growth, as measured by the gross national product in physical terms, has been 3.5 per cent per year, a rate nearly double the long-term growth rate of 2 per cent per year between 1909 and 1939. In the continuing fluctuations in the rate of growth which more or less inevitably characterize a relatively free economy, we have had some downs in recent years. **But our economy is now on the upbeat again. And at the end of this year, the U.S. economic growth rate for the postwar period can be expected to be 3.7 per cent per year.**

It is extremely important for the United States to continue to maintain this rate of economic growth or even to surpass it. Upon this effort depends our capacity to meet our defense requirements without dangerous strain, to provide an adequate margin for foreign aid, to improve our own productive facilities, and to continue to raise our own standard of living.

How not only to maintain but possibly improve upon our postwar pace of economic growth will be the subject of strenuous debate in the months ahead. However, the debate will have a much better chance of being constructive if the postwar growth record is seen in proper perspective. To this end one of the first things to do is to junk panic rousing statistical portrayals such as that in the Eckstein report.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

PRESIDENT

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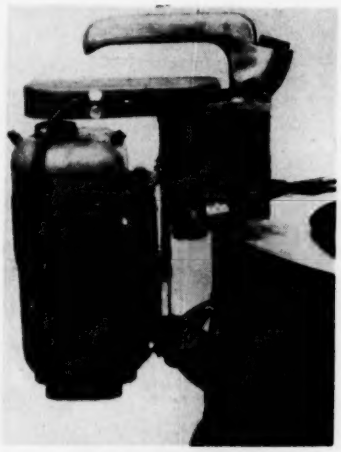
(*Continued from page* 74.)

visible at all times to promote operating efficiency. According to the manufacturer, unit takes less head and floor space for equal capacity, has low operating and maintenance costs. Filter media can be removed and replaced in 30 min.—**Straight Line Filters, Inc., Wilmington, Del.** **74D**



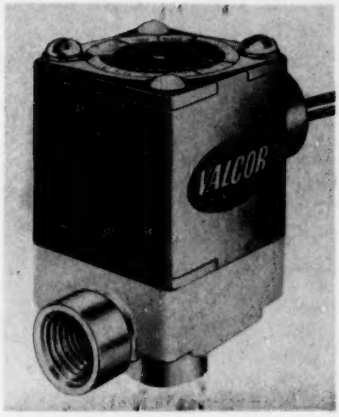
Steel Drum Opener

Cuts head out of any size drum in less than 2 min.

Labor no more to remove the heads of steel drums by hand. Model B. Wizard drum opener cuts the head out of any steel drum, 5 gal. to 60 gal., automatically. It can cut the center head only or take head and seam.

Unit is powered by a ⅓-hp. gear-head sealed-bearing motor which drives the cutter around the top of the drum. The power cord doesn't tangle because a swivel slip-ring socket turns as the unit goes around the drum, keeping cord free of cutter and operator.

Adjustment for drum diameters is made with one screw. Pressure on cutting head is similarly adjustable. Settings on both can be locked if a series of like drums are opened. Wizard mounts on special drum carriage for ease in opening small drums.—**Krist Machine Works, Milwaukee, Wis.** **135A**

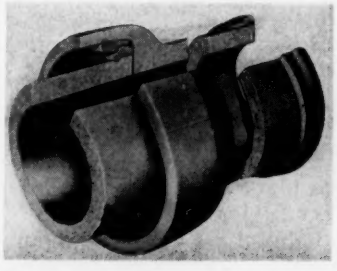


Solenoid Valves

Teflon bodies give lasting corrosion resistance.

Chemically inert, corrosion resistant solenoid valves are now available with molded teflon bodies. New valves are shock resistant, pressure proof, and will outlast steel in virtually any corrosive medium, according to the manufacturer.

Designed for normally closed applications in all normal a.c. and d.c. voltages, new valves complement line which already includes nylon and PVC valves for corrosive areas.—**Valcor Engineering Corp., Kenilworth, N. J.** **135B**

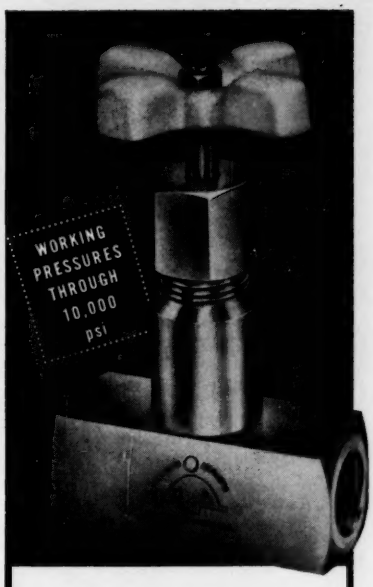


Waste-Pipe Seal

Plastic rings seal quickly in clay pipe joints.

Clay pipes for handling corrosive liquids and gases or ordinary sewage wastes can now be assembled quickly and permanently thanks to polyvinyl chloride plastisol seal rings.

New plastisol is resistant to all common acids, many strong bases, is flexible enough to with-



You can't meet today's needs with yesterday's valve!

Here is a needle valve for today's needs . . . the kind of product that only Marsh experience in *both* valve making *and* instrument making could produce . . . the one valve that gives precision throttling at *any* pressure — from a few pounds through 10,000 pounds.

For extra stamina and extra safety its body and stem guide are machined from solid bar stock. For greater precision, stem is accurately machined from hardened stainless steel and has fine, closely fitted threads that provide tighter shut-off; closer and more positive flow regulation. Special "Marpak" one-piece packing is long lasting and does not bind even when valves are used on higher pressures.

Marsh Needle Throttling Valves are made in a full range of sizes and patterns — either with steel bodies and stainless steel stems (type 1900) or in stainless steel throughout (type 1924).

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Division of Colorado Oil & Gas. Corp.,
Dept. 24, Skokie, Ill.
Marsh Instrument & Valve Co., (Canada) Ltd.,
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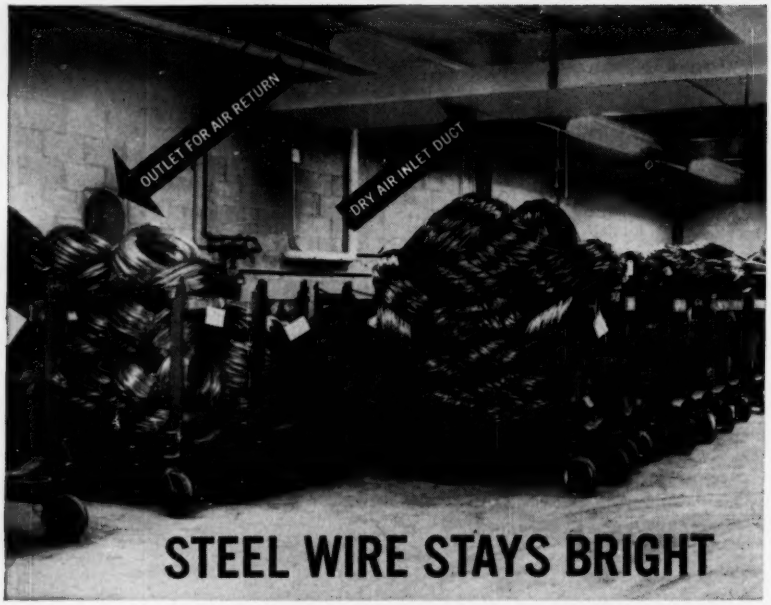
Houston Branch Plant, 1121 Rothwell
St., Sect. 15, Houston, Texas

MARSH *Needle Valves*

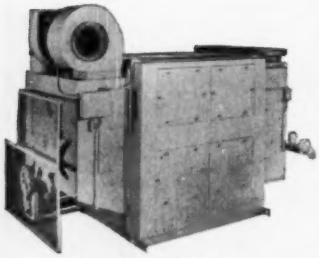


STEEL WIRE STAYS BRIGHT

IN DESERT-DRY WAREHOUSE

A LECTRODRYER maintains an average relative humidity of 16% the year around in Keystone Steel & Wire Company's storeroom at Peoria, Ill. As a result, bright steel wire exposed there to the atmosphere for a month was in excellent condition when received by the customer. Prior to dehumidification of the storage area, wire would begin to tarnish in a day or so.

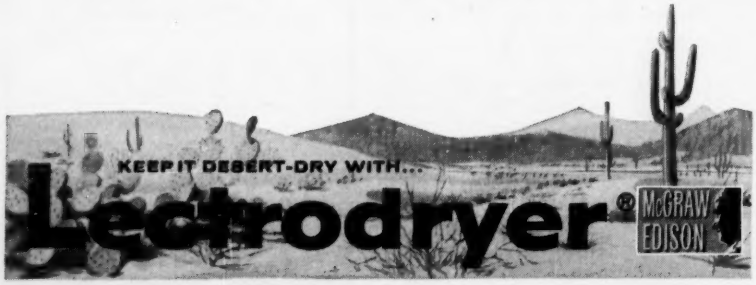
A DRY warehouse may solve your storage problems



New Type CH Lectrodryer

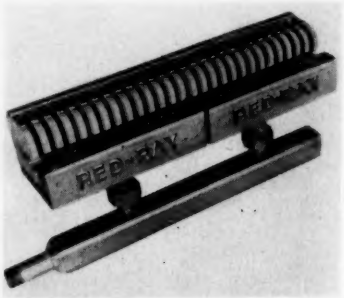
Hundreds of companies use Lectrodryers in a similar manner to dehumidify storage and work areas, thereby safeguarding products during warehousing, processing or packaging.

FOR CASE HISTORIES on these and for any other drying problem answers, write Pittsburgh Lectrodryer Division, McGraw-Edison Company, 303 32nd Street, Pittsburgh 30, Pennsylvania.



stand vibration and trench settlement, rigid enough to resist roots or other infiltration. Dubbed Wedge Lock, the joints are self - centering to give smooth flow characteristics.

Vitrified clay pipe using Wedge Lock joints meets ASTM and Federal clay-pipe specifications, comes with a complete line of fittings for industrial acid lines, fume ducts, brine systems and soil lines.—**Robinson Clay Product Co., Akron, Ohio.** 135C



Radiant Gas Heater

High-energy unit comes in any desired length.

Design of new gas burner makes combustion chamber unnecessary and stabilizes flame under high velocity circulation conditions. High-radiation unit provides from 150 to 3,000 Btu./in. depending on gas-air mixture, says manufacturer.

Combustion takes place completely within the fluted refractory which attains temperatures to 2,600 F. when operated in the open. Alloy type burner is for elevated temperatures; cast iron is for open applications.

Burners, which can be made in any length from 7 in. up, may be used for paint baking, heat setting or treating, resin curing, or any service requiring radiant heat.—**Red-Ray Mfg. Co., Cliffside Park, N. J.** 136A

BRIEFS

New urethane foam pipe insulation snaps over pipe for quick installation. Light weight, pliable, moisture-proof material named Thermax has

working temperature range of –300 to 275 F. — **American Cellular Co., Inc., New Castle, Del.** 136B

Diagonal ridges on top enable conveyor belt to carry wet sand, gravel, dry grain and other materials up 15-20 deg. slopes. Ridges can be aligned either to carry moisture with material or to allow water run-off. Belt comes in 12 to 30 in. widths.—**Hewitt-Robins Inc., Stamford, Conn.** 137A

Leak-proof check valve holds 5,000 psi., according to manufacturer, due to one-piece body design and O-ring seal. Tested at 7,500 psi., valve operates at –65 to 275 F., opens at 1 psi. Sized from ⅛ to 1 in., construction is in various metals. — **Quality Control Corp., Chicago, Ill.** 137B

New "slim design" splash deflector in 3 in. size will fit through 3½ in. tank opening, allow maximum filling flow without disturbing sediment in tank bottom. No. 615 is iron, aluminum, or cadmium plated.—**Universal Valve Co., Elizabeth, N. J.** 137C

Equipment Cost Indexes . . .

	Dec. 1959	Mar. 1960
Industry		
Avg. of all.....	237.0	237.8
Process Industries		
Cement mfg.	231.1	232.4
Chemical	239.0	240.0
Clay products	224.6	225.8
Glass mfg.	225.6	226.6
Paint mfg.	228.7	229.7
Paper mfg.	230.2	231.3
Petroleum ind.	233.6	234.7
Rubber ind.	236.5	237.5
Process ind. avg...	235.4	236.3
Related Industries		
Elec. power equip...	242.1	242.8
Mining, milling	240.4	241.5
Refrigerating	267.3	268.4
Steam power	223.9	224.9

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124–6 for method of obtaining index numbers; Feb. 23, 1959, pp. 149-50 for annual averages since 1913.

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When pressures rise above predetermined safe limits, this disc ruptures to provide instantaneous, unrestricted relief. BS&B designs discs to rupture at any specified pressure from 3 to 100,000 pounds per square inch. They are supplied in sizes ranging from ⅜-inch to 36 inches diameter, and in special sizes to virtually any specification.

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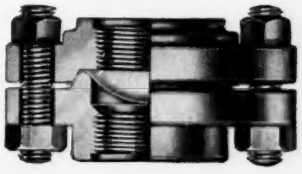

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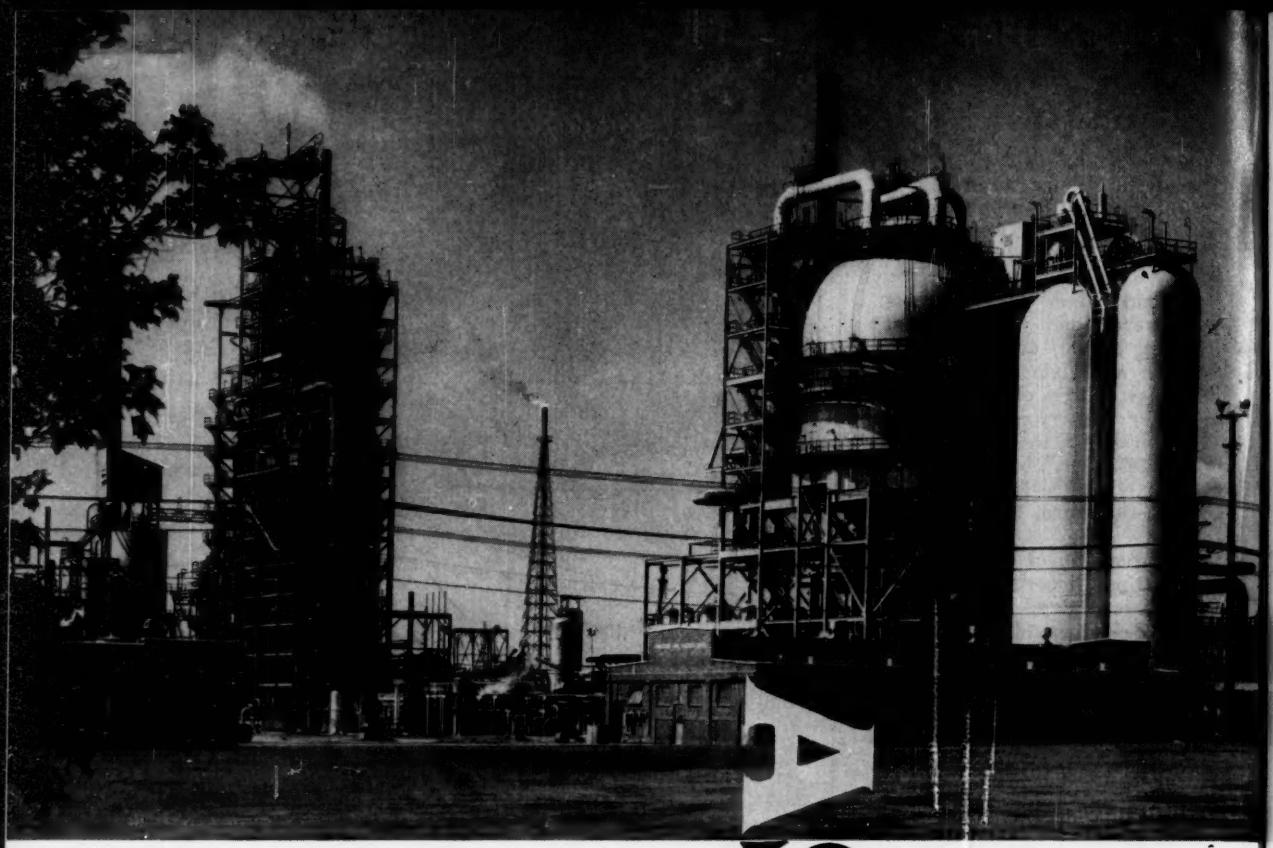

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New York: Digby 4-9460

PHILADELPHIA 3, PENNA.
Locust 7-5129

PITTSBURGH 24, PENNA.
Museum 2-2410

PORTLAND 9, OREGON
Capitol 7-1404

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TECHNICAL BOOKSHELF

Sound Primer

ELEMENTS OF ION EXCHANGE. By Robert Kunin. Reinhold Publishing Corp., New York, 164 pages. $5.75.

Reviewed by Frederick C. Nachod, Sterling-Winthrop Research Institute, Rensselaer, N. Y.

A sound primer of ion exchange, this booklet covers history, synthesis of material, theory and applications. It's written by an expert, Dr. Kunin, with the help of some of his associates at Rohm and Haas. Only marring feature would be the price—rather high considering that a similar primer on ion exchange, prepared by the Dow group, is distributed gratis, at least to academic personnel.

Unrecommended

AN INTRODUCTION TO THE ORGANIC CHEMISTRY OF HIGH POLYMERS. By Carl S. Marvel. John Wiley & Sons, New York. 79 pages. $4.50.

Reviewed by Walter Brenner, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Here we have a brief discussion of some of the chemical considerations involved in the synthesis of high polymers. It is described as derived from the Humble Lectures in Science which were given by Dr. Marvel in June 1956. The purpose of yet another volume on the already voluminous literature on high polymer chemistry is stated by Dr. Marvel to be "a means of interesting young organic chemists in the synthesis of new organic polymers."

Dr. Marvel's approach in this book is almost entirely that of the organic chemist. A minimum of consideration is given to the role of organic physical chemistry, etc. The treatment throughout this slender volume is strictly qualitative. Little if any information is presented on the properties of polymers and the relationship of structure to properties. It is believed that such discussions would be most helpful in meeting the avowed objective of this book. As several other books are available which—in the opinion of this reviewer—meet Dr. Marvel's objectives more satisfactorily, this book cannot be recommended to the beginner in polymer synthesis and appears to be of but little value to those versed in this field. It is also priced way out of proportion to the amount of written matter presented.

MORE NEW BOOKS

POLYESTER RESINS. By J. R. Lawrence. Reinhold. $5.75.

PRINCPLES OF CHEMICAL THERMODYNAMICS. By C. E. Reid. Reinhold. $7.80.

PHOTOCHEMISTRY IN THE LIQUID AND SOLID STATES. Ed. by L. J. Heidt et al. Wiley. $6.

OPTICAL CRYSTALLOGRAPHY. 3rd ed. By E. E. Wahlstrom. Wiley. $8.50.

SYSTEMATIC ANALYSIS OF SURFACE-ACTIVE AGENTS. By M. J. Rosen & H. A. Goldsmith. Interscience. $13.50.

RADIATION PYROMETRY AND ITS UNDERLYING PRINCIPLES OF RADIANT HEAT TRANSFER. By T. R. Harrison. Wiley. $12.

MODERN PROBABILITY THEORY AND ITS APPLICATIONS. By E. Parzen. Wiley. $10.75.

ADVANCES IN PEST CONTROL RESEARCH. VOL. III. Ed. by R. L. Metcalf. Interscience. $14.50.

HETEROCYCLIC CHEMISTRY. By A. R. Katritzky & J. M. Lagowski. Wiley. $4.75.

PROPULSION SYSTEMS FOR SPACE FLIGHT. By W. R. Corliss. McGraw-Hill. $10.

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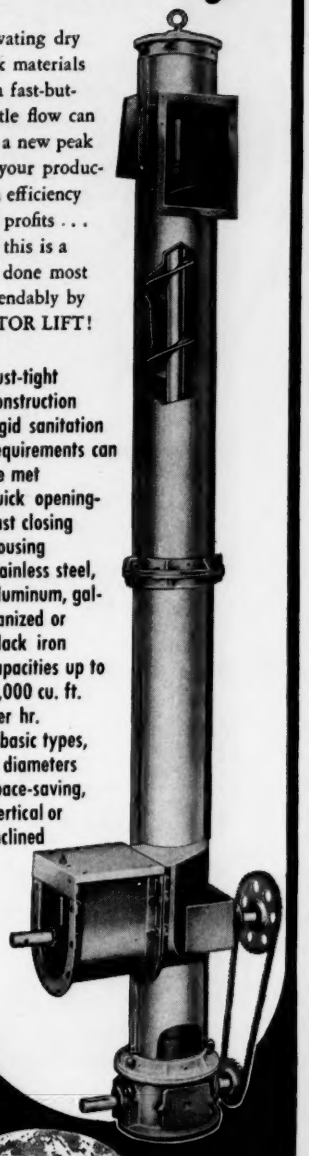

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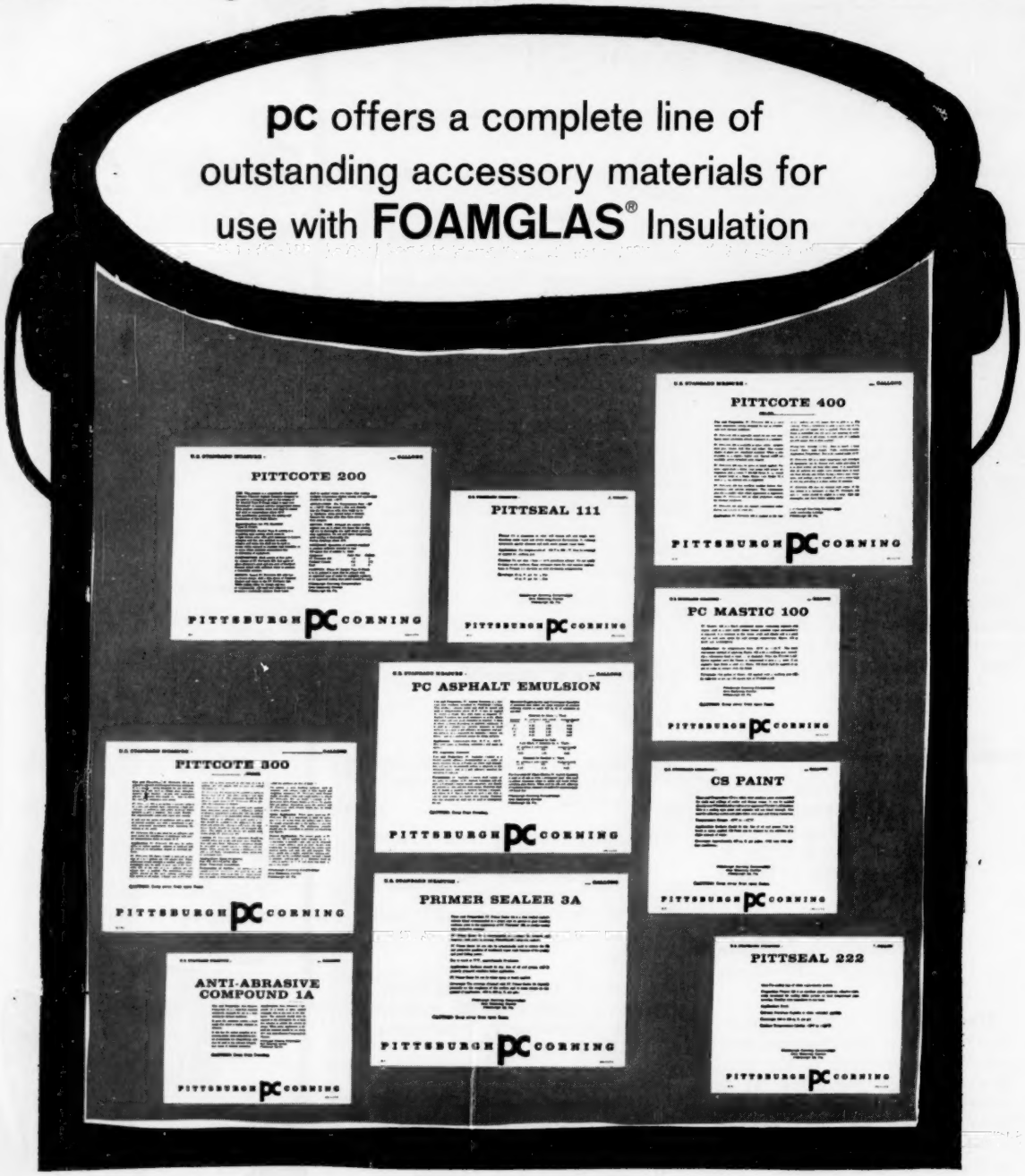

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LETTERS: PRO & CON

C. H. CHILTON

Filter Costs Too High

Sir:

We are very much interested in the Cost File in your Mar. 21 issue (pp. 173-176). The idea is very interesting and must have taken a tremendous amount of work.

However, we were dismayed to note that the price factors for plate-and-frame filter presses seemed to be high by a goodly margin. For example, a 100-sq.-ft. cast iron filter is given by the nomograph at $2,300, whereas actual price is less than $1,300. Likewise, the actual price for a 100-sq.-ft. stainless steel filter is less than $5,000, rather than the $13,000 shown by the nomograph.

We would not quarrel if the accuracy was within 10-15% of the actual price, but when there is a discrepancy of 75-100%, I think some notice should be taken.

J. LAWRENCE HUTTON, JR.
T. Shriver & Co.
Harrison, N. J.

▶ *We have gone back to the primary literature sources in order to account for these discrepancies. Apparently the nomograph was based on an erroneous secondary reference in which installed cost was mislabeled purchase price. For filter presses, installed cost runs approximately 1.75-2.0 times purchase price.*—ED.

Pro: Thinner Files

Sir:

While arranging periodicals for binding it occurred to me that the layout of *Chemical Engineering* is quite different from European journals of similar technical content.

It is reasonable to save advertising information for a year or two. However, it is certain that the advertising literature of 1950, or even 1957, is obsolete by now.

The pages in *CE* containing worthwhile technical information on one side and advertising on the other side consist on the average of 25-45% of the total number of pages for binding. Required shelf space for bound copies could be greatly reduced if your editorial pages did not also carry advertising. The benefit to libraries and their parent organizations would be tremendous.

M. MEDWIED
Israel Mining Industries
Haifa, Israel

A Ch. E.'s Self-Image

Sir:

Here is a short opus—half prose, half nonsense—which I wrote with the inspiration of the first three lines from some forgotten source.

A Chemical Engineer is a man who knows . . .

- *Enough engineering to confuse the chemists,*
- *Enough chemistry to confuse the draftsmen,*
- *Enough mathematics to confuse his boss,*
- *Enough electricity to confuse himself.*

His world consists of a series of simplifying assumptions and derived basic equations—all of which he is sure are true because they can be integrated twice.

The Chemical Engineer is a well trained . . .

- *Pipefitter*
- *Machinist*
- *Metalworker*
- *Test-tube washer*
- *Coffee drinker*

And as long as he never has to solve a problem different from the examples in Walker, Lewis, McAdams and Gilliland, he'll go on collecting his paycheck as long as he can crawl over to the payroll office.

Everyone in our department got such a big laugh out of it I thought you might like to pass it on to the many readers of *Chemical Engineering.*

RICHARD H. OKENFUSS
School of Mines & Metallurgy
Rolla, Mo.

General Kinetics Corp.

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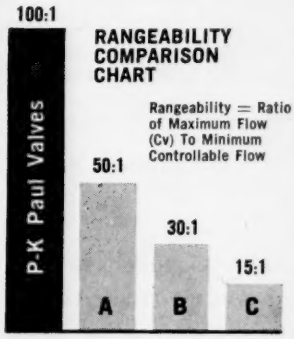
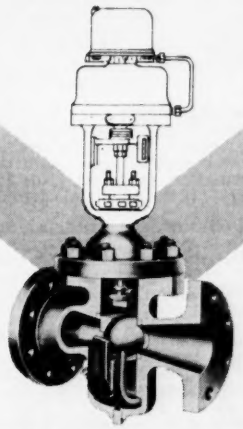


A—Globe Valves, V-Port Plug
B—Globe Valves, Contoured Plug
C—Butterfly Valves



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TECHNICAL LITERATURE

E. M. FLYNN

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Chemicals

Acetic Acid.....is used in the manufacture of cellulose acetate fiber & plastic, vinyl monomers, solvents, dyes, metal salts, pharmaceuticals & other chemicals. Information.
12-13 *Celanese Chem. Co.

Aerosol Chromatography Reagents..... from one source include amilene-hydrogen phthalate, p-anisidine hydrochloride, bromcresol green, ferric chloride, isatin, ninhydrin.
75-76g *U. S. Industrial Chemicals Co.

Ammonium Sulfate.....in a specially purified grade, designed for use as a reagent in enzyme research, is now being supplied. Additional information available. No. 1595.
75-76k *U. S. Industrial Chemicals Co.

Buton Resins.....are suggested for use in primer formulations for appliances, automobiles & metals of all types. Further information is available on request.
162-163 *Enjay Co., Inc.

Catalog.....36-page booklet includes short descriptions, uses and prices of essential oils, aromatic chemicals and specialties and certified colors that are listed.
142A Dodge & Olcott, Inc.

Chemical.....The general properties, typical functions and uses of the new colloidal silica CAB-O-SIL are contained in a 7-page brochure which is now available.
142B Godfrey L. Cabot, Inc.

Chemicals.....A list of patents that are available on the use of Hydrogen Peroxide, Peroxygen Chemicals and Persulfate Chemicals is yours for the asking.
125a *Becco Chemical Div., FMC

Chemicals.....Latest compilation of facts about Benzotrifluoride & its Ortho-, Meta-, and Parachloro Isomers in Bul. 12-A. Covers physical & chemical properties, etc.
47 *Hooker Chemical Corp.

Chromium.....80-page technical bulletin gives properties and principal uses of material. Graphs and charts illustrate density, solubility, viscosity and pH of solutions.
142C Solvay Process Div.

Ethanol with Panthenol.....It has been suggested that panthenol be incorporated more widely into toilet preparations because of its healing action with wounds, lesions.
75-76d *U. S. Industrial Chemicals Co.

Ethanolamines.....Technical data and starting formulation on "soluble" oils—and oil & solvent emulsions, wax emulsions, oil & wax polishes, cosmetics, & detergents.
121 *Union Carbide Chemicals Co.

Fertilizers.....Brochure describes Carlile process for production of wet process phosphoric acid and ammonium phosphate fertilizers, including dl-ammonium.
142D J. C. Carlile Corp.

Fused Quartz.....A 30-page catalog outlines the properties of Vitreosil. Illustrates & describes the Laboratory Ware & Industrial Ware.
142E Thermal American Fused Quartz

Hexahydrophthalic anhydride..... Booklet lists chemical and physical properties, strength, physiological hazards and handling procedures and suggested uses of material.
142F National Aniline Div.

Hydrofluoric Acid.....A copy of M.C.A. Chemical Safety Data Sheet SD-25 on properties & essential information about...Hydrofluoric Acid Anhydrous and Aqueous.
25 *The Harshaw Chemical Co.

Molecular Sieves.....are always uniform, with high capacity, high strength, and high bulk density. Available in regular & special grades to meet specifications. Facts.
129 *Linde Co., Div. of Union Carbide

Olefin.....Brochure includes flow sequence of olefin plant and flow sheet design for an ethylene operation; discusses economic significances of olefin plant designing.
142G M. W. Kellogg Co.

Organic Chemicals.....Catalog provides detailed information on manufacturers products. List includes important reactants and processing agents used in many end products.
142H National Aniline Div.

Phenolic.....Brochure describes materials with fast cure times and wide molding latitudes. Maximum preform temperature is about 295F. or 20° higher than other compounds.
142I Union Carbide Plastics Co.

Platy Mica.....Research study bulletin No. 41 indicates that the addition of platy mica in highly purified water ground form has beneficial effects on acrylic latex paints.
142J Wet Ground Mica Assoc.

Polyethylene.....in finely divided or powdered form is now being produced & is available in sample & semi-commercial quantities under the tradename "Microthene".
75-76a *U. S. Industrial Chemicals Co.

Polyethylene.....8-page booklet describes powdered polyethylene, a new form of resin designed for application where conventional forms of the material cannot be used.
142K U. S. Industrial Chemicals Co.

Porcelain.....Catalog defines chemical porcelain, describes its manufacture and explains its properties and possibilities. Section defines most common ceramic terms.
142L Lapp Insulator Co.

Porous Metal.....Technical bulletin discusses new type of porous metal made by wire winding techniques; covers both filtration and non-filtration applications.
142M Bendix Filter Div.

Protective Coatings.....13-page booklet describes complete line of coal-tar protective coatings intended primarily as moisture barriers and impervious corrosion proofers.
142N Allied Chemical Corp.

Protective Coating.....is said to remove rust chemically & to place a protective film over the surface... all in one operation. Additional information in No. 1592.
75-76h *U. S. Industrial Chemicals Co.

Radioactive Compounds.....Catalog lists over 400 radiolabeled compounds with prices and quantity discounts given. Includes licensing and ordering information.
142O Nuclear-Chicago Corp.

Silicone.....12-page engineering guide explains how various physical forms of silicones contributed to reliability, miniaturization, modularization and environmental protection.
142P Dow Corning Corp.

Silicone Fluids.....now available are unusually compatible with diversity of materials. Soluble in many aliphatic hydrocarbons, lower alcohols including ethanol. No. 1594.
75-76j *U. S. Industrial Chemicals Co.

Sodium Nitrite.....Booklet "Sodium Nitrite for Rust and Corrosion Prevention" contains details about the many anti-corrosion uses of Sodium Nitrite. Also test sample.
63 *Allied Chem., Solvay Process Div.

* From Advertisement, this issue

Want to build up your files and keep them up-to-date? You can get any publication in this comprehensive guide — free — just for the asking.

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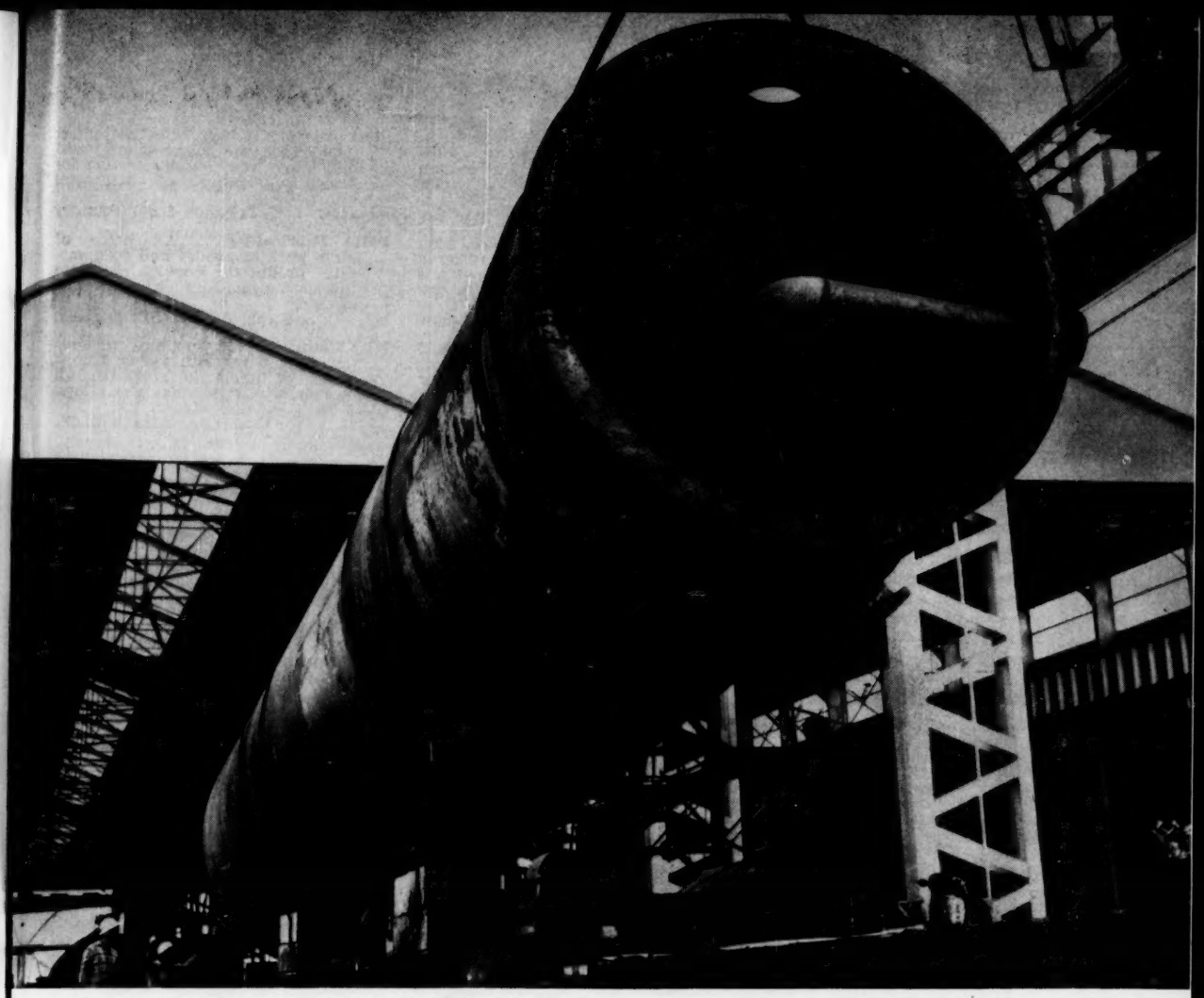

Designed by the Fluor Corporation, Ltd., for the Union Texas Natural Gas Corp.

It took a stork's big brother to deliver this 225-ton baby

High-capacity cranes were needed to handle this giant absorber unit (225 tons, 56′ long, 4″ shell), that required special attention and equipment all along the way. First, it was made of ASTM A212 Grade B Firebox Quality Plate, charpy impact-tested to 15 ft. lbs. @ —50°F. Then it was flame cut and roll formed. Its main stem was 100% radiographed, and its nozzle penetration was magnetic-particle inspected. The entire vessel was then stress relieved at 1150°F. for four hours. And finally, it was placed on special flat cars for delivery. □ This kind of job demands the complete, modern, high-capacity facilities that permit our Orange, Texas plate shop to handle all kinds of custom plate work. High-capacity cranes, mammoth car bottom furnaces, giant presses and bending rolls, the latest in welding equipment, and complete inspection facilities. This plus know-how and strategic location permit us to produce all kinds of plate work efficiently and economically. And anything we make, we can erect.

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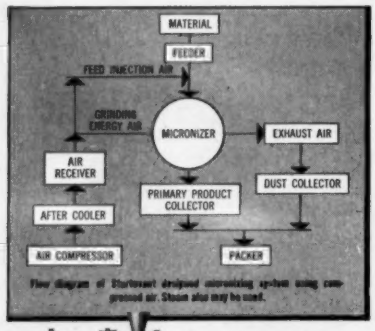


Flow diagram of Sturtevant designed micronizing system using compressed air. Steam also may be used.

One Operation Reduces, Classifies

Sturtevant Micronizers grind and classify in one operation in a single chamber—provide fines in range from ½ to 44 microns to meet today's increased product fineness needs. Can handle heat-sensitive materials.

Production Model (15 in. chamber)

No Attritional Heat

Particles in high speed rotation, propelled by compressed air entering shallow chamber at angles to periphery, grind each other by violent impact. Design gives instant accessibility, easy cleaning. No moving parts.

Classifying is Simultaneous

Centrifugal force keeps oversize material in grinding zone, cyclone action in central section of chamber classifies and collects fines for bagging. Rate of feed and pressure control particle size.

Eight Models Available

Grinding chambers range from 2 in. diameter laboratory size (½ to 1 lb. per hr. capacity) to large 36 in. diameter production size (500 to 4000 lbs. per hr. capacity). For full description, request Bulletin No. 091.

Engineered for Special Needs

A 30 in. Sturtevant Micronizer is reducing titanium dioxide to under 1 micron at feed rate of 2250 lbs. per hr. For another firm, a 24 in. model grinds 50% DDT to 3.5 average microns at a solid feed rate of 1200-1400 lbs. per hr. A pharmaceutical house uses an 8 in. model to produce procaine-penicillin fines in the 5 to 20 micron range. Iron oxide pigment is being reduced by a 30 in. Micronizer to 2 to 3 average microns.

Sturtevant will help you plan a Fluid-Jet system for your ultra-fine grinding and classifying requirements. Write today.

Can Test or Contract Micronizing Help You?

Test micronizing of your own material, or production micronizing on contract basis, are part of Sturtevant service. See for yourself the improvement ultra-fine grinding can contribute to your product. Write for full details. STURTEVANT MILL CO., 100 Clayton St., Boston, Mass.

*REGISTERED TRADEMARK OF STURTEVANT MILL CO.

LITERATURE . . .

Sodium Peroxide.....Specifications, typical analysis, properties, shipping data & uses of U.S.I. sodium peroxide are included in a new technical data sheet.
75-76c *U. S. Industrial Chemicals Co.

Sulfuric Acid.....Specific information on how General Chemical can serve your sulfuric acid requirements is now available on request. Extensive production facilities.
39 *General Chem. Div., Allied Chem.

Vitron.....Pamphlet covers technical aspects of material particularly as used in Stillman seals and gaskets, and discusses temperature ranges and physical properties.
144A Stillman Rubber Co.

Construction Materials

Aluminum Electrical Rigid Conduit.... needs no protective coating, because it forms its own—an oxide film that repairs itself when damaged. Full details.
14-15 *Rome Cable Div. of Alcoa

Aluminum Tanks & Vessels.....are corrosion-resistant, lightweight, easy to fabricate & offer excellent thermal characteristics & low temperature properties. Brochure.
36-37 *Reynolds Metal Co.

Gas Turbines.....Detailed data on Solar gas turbines and other turbomachinery for your service requirements is now available on request.
30 *Solar Aircraft Co.

Hard Carbide Alloys.....Information in Booklet B-111A, "Characteristics of Kennametal," Booklet B-222, "Designing with Kennametal," Booklet B-444A, "Kentanium."
152 *Kennametal Inc.

Insulation Accessories.....A complete line specifically designed for use with Foamglas insulation. A set of Accessory Material Data Sheets is available.
140 *Pittsburgh Corning Corp.

Lead Products.....These products include chemical lead sheets to your requirements; pipe, bends, traps and standard fittings. Lead Hand-Book Bulletin No. 162.
138 *American Smelting & Refining

Metal Pall Rings.....are available in ⅝", 1", 1½" & 2" sizes in carbon steel, stainless steel, nickel, monel, iconel, titanium, copper & aluminum.
32 *U. S. Stoneware

Pipe Insulation.....Kaylo-Klad offers excellent thermal efficiency for temp. up to 1200 F. in all standard sectional pipe sizes & in thicknesses to 3". Lit.
6-7 *Owens-Corning Fiberglas Corp.

Plastic.....Ryertex-Omicron PVC offers outstanding resistance to 281 corrosive solutions & gases. It is immune to weather, rotting & aging. PVC Bulletin 80-3.
86 *Joseph T. Ryerson & Son, Inc.

Plastic Steel.....is a combination of approximately 80% steel & 20% of a newly developed plastic. Can be formed into any shape. Illustrated booklet.
144B Devcon Corporation

Steel Alloys.....New reference chart lists 55 of the more widely used cast alloys and contains section for design applications of each steel alloy.
144C Lebanon Steel Foundry

Plate Fabricating.....All kinds of plate work efficiently and economically produced. Booklet on plate fabricating facilities and services is offered.
143 *U. S. Steel, American Bridge Div.

Wire Cloth.....for your most diversified bulk wire cloth needs. Thousands of items in stock in all meshes, wire sizes, metals or alloys. A 94-pg. catalog offered.
22 *The Cambridge Wire Cloth Co.

Electrical & Mechanical

Connectors & Panels.....Quick-coupling connectors permit fast making & breaking of circuits. Panels are available in many compact shapes & sizes. Bulletin 23-4.
B160 *Thermo Electric Co., Inc.

Fluid Drive.....20-page illustrated bulletin No. A-719 discusses principle of operation and shows typical applications of adjustable speed fluid drive unit.
144D American Standard

Linear Operator.....The new, automatic, compact LimiTorque linear motorized valve operator is covered in detail in Bulletin 20-58. Operates your plug valves in 8 to 16 seconds.
24 *Philadelphia Gear Corporation

Motors Induction.....14-page booklet includes basic information needed by most motor users. Application chart gives types recommended for various loads.
144E General Electric Co.

Motors, Vertical Solid Shaft.....are available in standard ratings of 60 cycle, 208-222/440 & 550 volt, 1½ through 40 hp-3500 RPM, & 1 through 30 hp-1750 RPM.
115 *Wagner Electric Corp.

Power Transmission Components..... Cat. SP-59 covers the complete range of roller chain drives, silent chain drives, etc. Also flexible couplings, clutches, speed reducers, etc.
144F Morse Chain Co.

Rectifiers, Silicon.....Full information on silicon rectifiers for electrochemical applications. Advantages include, low first cost, ease of installation, etc.
16-17 *Westinghouse Electric Corp.

Speed Control.....Ampli-Speed has nearly stepless speed change & gives speed regulation within ±2%. Illustrated publication No. 243 tells how it works.
148 *Electric Machinery Mfg. Co.

Thermocouples.....MegopaK thermocouples manufacturing area is clean, dry, air-conditioned. Information, including Catalog and Price List G100-4 now available.
55 *Minneapolis Honeywell

Turbines.....A complete range of power-packed turbines from 1 HP to 250 HP. Further facts on turbines contained in the new Catalog 200.
85 *Coppus Engineering Corp.

* From Advertisement, this issue

Handling & Packaging

Automatic Batching.....Several types of remote-control batching systems for today's needs, including punch card, "Formulaplug" and digital scanner covered in Bul. 2964.
145o *Toledo Scale Corp.

Automatic Checkweighers.....Models to provide continuous 100% in-line checkweighing of items from a few ounces to 200 lbs. Handle sacks, cartons, etc. Bul. 2968.
145b *Toeldo Scale Corp.

Conveyor Drives.....adaptable to conveyors of all types, agitators, screw conveyors, machines, & for any other transmission of power. Illustrated catalogs.
34 *Morse Chain Co.

Conveyor Scale.....4-page bulletin, on use of conveyor scale systems for flow-rate control and total thruput measurement of bulk materials, explains system operation.
145A Weighing & Control Comp. Inc.

Elevator, Vertical Screw.. The Rotor-Lift elevates & conveys bulk chemicals. Handles capacities up to 6,000 cu. ft. per hr. Engineering catalog is available.
139 *Southwestern Supply & Machine

Fork Truck.....Dimensional and engineering specifications and operational advantages of 2500 lb. capacity, battery powered fork truck presented in 6-page brochure.
145B Clark Equipment Co.

Load Cell Scales....The advantages of load cell operation are available in . . . axle load scales . . . motor truck scales . . . crane scales . . . hopper scales etc. Bul. 2970.
145c *Toledo Scale Corp.

Payloader.....offers many features such as 2,500 lbs. carry capacity, power-shift transmission, power steering, power-transfer differential, etc. Data on H-25 "Payloader".
31 *The Frank G. Hough Co.

Sub-Surface Filler.....automatically eliminates foaming and controls drum filling. Provides faster, more accurate filling. Additional information in Bul. 9030.
145d *Toledo Scale Corp.

Heating & Cooling

Boilers.....Vapor Modulatic water tube boilers furnish high or low-pressure steam (at design pressures up to 1000 psi, or even higher). Bulletins offered.
131 *Vapor Heating Corp.

Dielectric Heaters.....Typical applications include: twist-setting rayon cord, jelling rubber, heating enert powders, preheating molding powders, & drying rayon.
51 *Allis-Chalmers

Heat Exchangers.....Information on the advantages of price & excellent corrosion-resistance of "Karbate" impervious graphite shell & tube exchangers is offered.
53 *National Carbon Co.

* From Advertisement, this issue

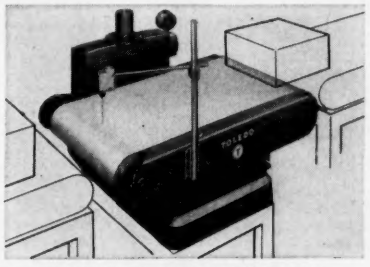
TOLEDO Reports on Automatic Weighing

★ NEW IDEAS FOR COST-SAVING

Chance of human error is eliminated in this Toledo system. Each formula is preset on a "Batchboard". The control panel can be located as desired in relation to the scales.

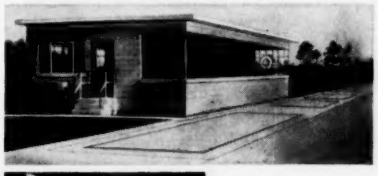
AUTOMATIC BATCHING

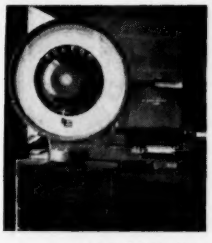
Operator at convenient remote location has full command of a multiple scale batching system with Toledo Remocon. As many formulas as required are pre-set on "Batchboards" and inserted into panel. This is one of several types of Toledo remote-control batching systems for today's needs, including punch card, "Formulaplug" and digital scanner. Ask for Bulletin 2964.



CHECKWEIGHS IN-MOTION

Many plants today are putting Toledo Automatic Checkweighers into their conveyor lines. Models to provide continuous, 100% in-line checkweighing of items from a few ounces to 200 pounds. Motorized belt. Handle sacks, cartons, packages, pieces, parts. Ask for Bulletin 2968.

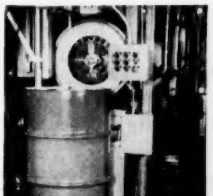




LOAD CELL DIAL DOES TRIPLE DUTY

. . . ALSO PRINTWEIGH RECORDING

One remote dial serves *three* platforms in this Toledo Electronic Load Cell Scale for truck weighing at a large cement plant. With a truck on three platforms, scale reads individual axle loads or total weight. Equipped with Printweigh "400" to print full figure weight data. Brings new versatility to weighing. Request Bulletin 2970.



AUTOMATES DRUM-FILLING

In this oil industry plant, a Toledo sub-surface filler automatically eliminates foaming and controls drum filling. The scale is keyed into conveyorized system . . . provides faster, more accurate filling. Saves time, labor, avoids loss of material and customer goodwill. One of many operations where Toledo controls guard costs. Ask for Bulletin 9030.

●

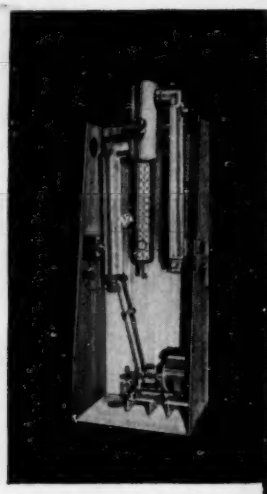
WRITE TODAY for specialized help from our Custom Products Division, or contact the Toledo Office near you, to solve your problems in batching, checkweighing, drum-filling, load cell applications. TOLEDO SCALE, Division of Toledo Scale Corporation, Toledo 12, Ohio.

(Toledo Scale Co. of Canada, Ltd., Windsor, Ont.)

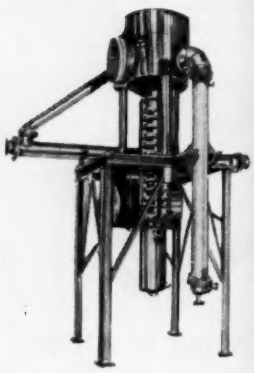
SERVICE Factory-Trained 340 Cities

TOLEDO®

Headquarters for Weighing Systems



the
ARTISAN
evaporator
stripper...



HOW IT WORKS: Contaminated solvent is pumped or gravity-fed to a steam-heated evaporator where 80-90% of the solvent is evaporated in a single pass. Vapor is separated in a vapor chamber. Liquid then flows to jacketed tube and disk stripping column where remaining contaminants are removed. Vapor proceeds to condenser where it returns to pure solvent.

RECOVERY RATE- *99% plus*
COST- *less than a penny a gallon*

This newly designed Artisan system is particularly useful for recovering chlorinated hydrocarbons from relatively non-volatile contaminants with a high rate of solvent recovery on a continuous basis.

You can obtain recovery rates of 98–99% without stripping steam. With steam, recovery rate climbs to 99.9%. Based on figures from the field, cost is less than one cent per gallon.

Applications: hydrocarbons; plasticizers, glycerine, fatty acids, heavy concentrates, heat-sensitive materials like vitamins, separating solvents from greases and resins, removing volatiles from polymers.

For complete information write:
ARTISAN METAL PRODUCTS, INC.
76 Pond Street, Waltham 54, Massachusetts
A MEMBER OF ARTISAN INDUSTRIES

LITERATURE . . .

Heat Transfer.....New Multi-Zone Plate-coil offers operating pressures up to 250 psi in all kinds of tank and process heating. Bulletin P 61 for more data.
127 *Tranter Mfg., Inc.

Panelcoil.....Technical Data Sheets Nos. 15-60 Series giving engineering specifications on Deal Panelcoil and also price lists are now available.
T161 *Dean Products, Inc.

Rotary Flash Air Cooler.....Complete information on Rotary Flash Type Air Cooler is contained in Catalog "A". It is available new.
B161 *Davenport Machine & Foundry

Steam Traps.....The 44-page steam trap book discusses trap selection, installation and maintenance. Covers its excellent air handling characteristics.
26 *Armstrong Machine Works

Steam Traps.....operate on a true balanced pressure principle . . . they have only one moving part. Offer positive shut-off, high capacity & rigid pretesting. Catalog.
132 *W. H. Nicholson & Co.

Instruments & Controls

Gas Chromatography.....Catalog illustrates and describes modular instruments for gas chromatography. Several systems are illustrated of the many possible combinations.
146A Research Specialties Co

Lamp Annunciators.....for machine & equip. supervision, process control, automation systems in power plants, sub-stations, oil refineries, industrial plants. Bul. A-200.
146B Edwards Company, Inc.

Liquid Level Controls....Floatless Electrode type are unaffected by acids or caustics. Standard 2 & 3 pole units listed by U/L. Complete specifications in 32-pg. Catalog.
T160 *Charles F. Warrick Co.

Pneumatic Transmitter.....The new M/45 pneumatic indicating transmitter with matched elements for six different process variables is covered in Bulletin 13-30.
27 *The Foxboro Co.

Telemeters.....52-page bulletin includes information on principles of operation, application to various measurands and electric quantities of this control instrument.
146C The Bristol Co.

Temperature Control.....Simple and inherently stable temperature control packages applicable to a wide variety of industrial processes are described in 12-page bulletin.
146D Assembly Products Inc.

Temperature Control.....Manual, intended as guide in selection of automatic heating and cooling controls, contains technical directory listing additional literature.
146E Powers Regulator Co.

Radiation Thermometer....Leaflet discusses operation of thermometer that remotely measures temperatures of moving and inaccessable surface without contact.
146F Radiation Electronics Co.

* From Advertisement, this issue

LITERATURE . . .

Ultrasonic Flaw Detector.....Techniques and specifications of the Sonoray Model 5 are included in booklet. Also describes the three accessory plug-in flaw alarms.
147A Branson Ultrasonic Corp.

Ultrasonic Thickness Testers.....are portable, batter-operated resonance type instruments for measuring thickness of a wide variety of metals, glass, etc. Booklet.
147B Branson Ultrasonic Corp.

Pipe, Fittings, Valves

Fittings.....Catalog covers Cosasco Access Fitting principle, High-Pressure Retrievers & the line of instruments for complete corrosion surveys without system shutdown.
147C Grant Oil Tool Co.

Heated Gages and Valves.....Data sheet gives well detailed information on equipment that has wide application where liquids must be kept at high temperatures.
147D Jerguson Gage & Valve Co.

Hose Rubber.....24-page catalog discusses complete line of over 35 types of hose used throughout manufacturing and processing industries. Includes section on hose fittings.
147E Mercer Rubber Co.

Pipe, PVC.....Koroseal PVC pipe is ideal for use wherever chemical resistance, high working pressures & good impact resistance are factors. Booklet offered.
1 *B. F. Goodrich Indust. Prod. Co.

Tubing.....Full information on Job-Matched Seamless Pressure Tubing is contained in Bulletin TB-417. Wide size range & uniform dimensions & mechanical properties.
82 *The Babcock & Wilcox Co.

Valve.....New Type G Sleeveline is a non-lubricated plug valve. For sulfuric acid service, caustic service, solvent handling, etc. Bulletin V/12.
117 *The Duriron Company, Inc.

Valves.....A "22 x 17" wall chart, "How to Protect Your Valves" is offered. Contains installation pointers, operating tips, etc.
41 *R-P & C Div., Amer. Chain Cable

Valves.....Corrosion-Resistant valves are available in a wide selection of materials. Handle practically every know corrosive media. Complete details.
119 *The Wm. Powell Co.

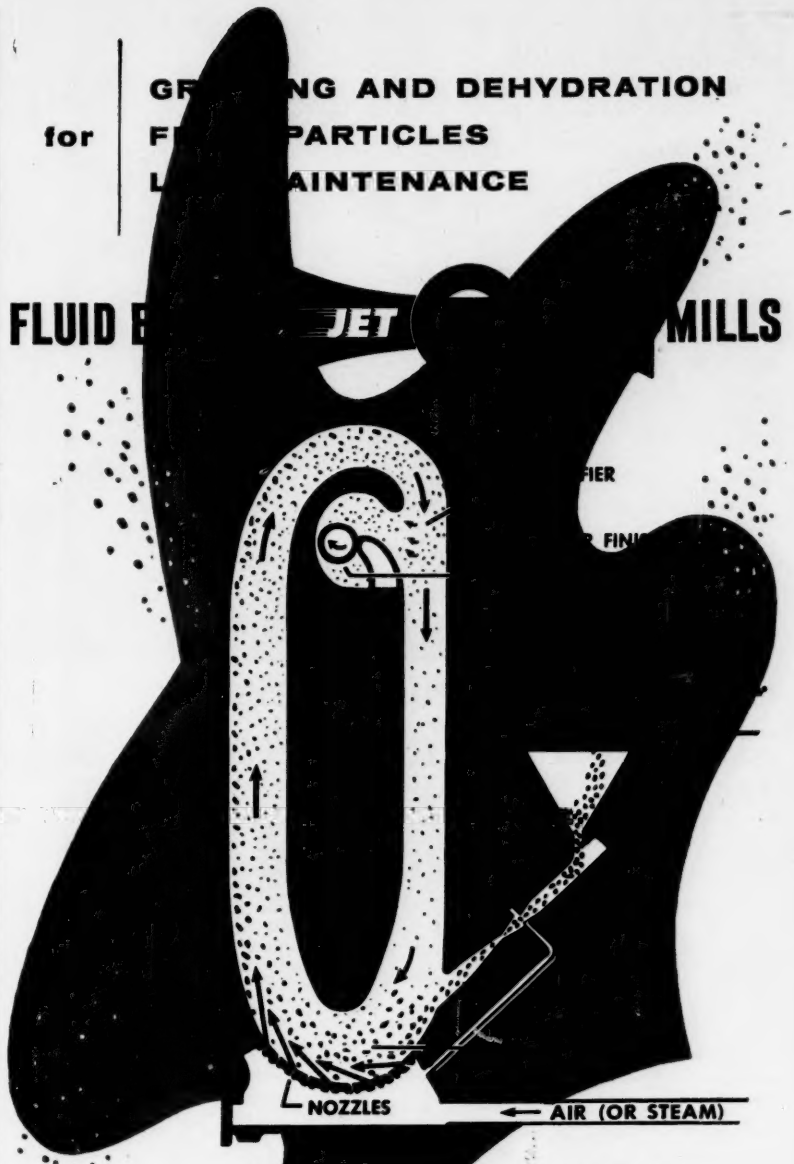
Valves.....feature heat and wear resisting stainless steel yoke nuts. Valves available in a complete range of sizes from ¼" to 2". Catalog F-10 available.
113 *Henry Vogt Machine Co.

Valves, Control.....feature positive shut-off, non-turbulent flow, low operating thrust, self purging, etc. Resistant to erosion & abrasion. Tech. Catalog GV101.
141 *General Kinetics Corp.

Valves, Needle Throttling.....are made in a full range of sizes and patterns, either with steel bodies & stainless steel stems or in stainless steel throughout. Bulletin.
135 *Marsh Instrument Co.

* From Advertisement, this issue

for



The Fluid Energy "Jet-O [illegible] gned and built by the pioneers in fluid energy fine grindi [illegible] ore than produce fine particles. It controls fineness and prod [illegible] ity with a narrow distribution range and simultaneously with grinding can dehydrate, coat particles, blend and achieve chemical changes.

Jet-O-Mizer Mills are being used all over the world, processing many types of materials in the following industries:

• Abrasive	• Food	• Pigment	• Wax
• Insecticide	• Mineral	• Plastic	• Metal
• Ceramic	• Pharmaceutical	• Carbon	• Chemical

"*Jet-O-Mizing*" produces **FINE PARTICLES** ¼ micron average and above **PLUS** . . . Narrow Particle Distribution • Dry, or Controlled Moisture Content • Continuous Operation • Uniformity of End Product • Other Operations with Grinding • No Attritional Heat — No Moving Parts • Low Operating Costs • Low Maintenance

Send for complete information on Fluid Energy's "Jet-O-Mizer" Mills, "Jet-O-Clone" Dust Collectors, and TESTING AND CUSTOM GRINDING services.

FLUID ENERGY PROCESSING & EQUIPMENT COMPANY
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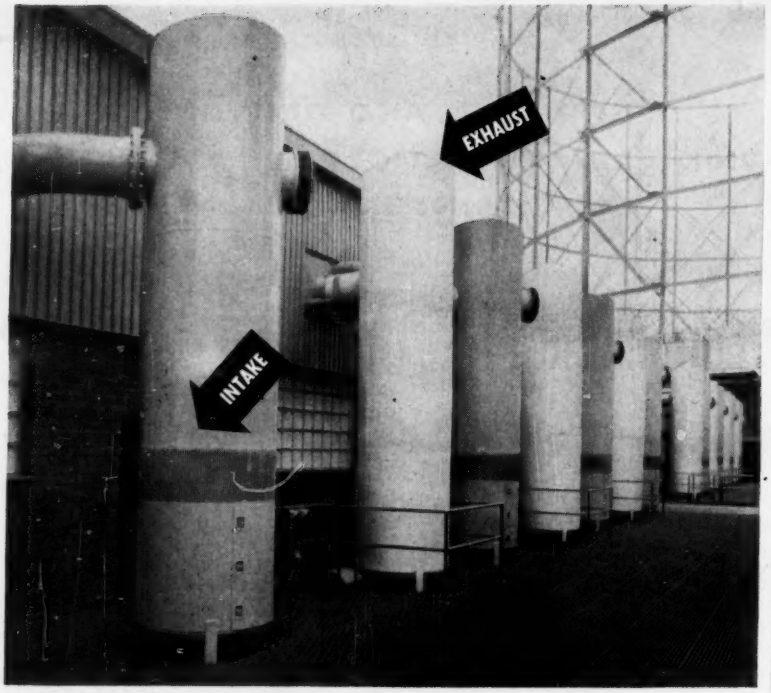
(Formerly known as the Wheeler-Stephanoff Mill)



For remote- or engine-mounted turbochargers

SILENT TWINS Increase Operating Efficiency... Provide Clean, Filtered Air Intake and Optimum Exhaust Silencing

Burgess-Manning Silent Twins, matched units for remote- or engine-mounted turbochargers, provide clean, filtered intake air at minimum pressure drop and optimum silencing efficiency on both sides of the system. Silent Twins are available for vertical or horizontal installation, and afford flow-conditioned, compact piping for best operating efficiency of either proposed turbocharged engines or turbocharging of existing engines.

Silent Twins can be furnished with either of two types of filters — depending upon the dust load. One is petrolatum-treated hogshair, extensively used in the Gulf Coast area, the Eastern United States, and other light dust load areas. For the Western United States and in areas where heavy dust is a factor, we recommend a special felt material that will load up and hold dust and dirt of a very small micron size without carrying over to the engine. Both types have proved to be the best-accepted, lowest-cost, and lowest-maintenance filters available. The filters are contained in a compact cartridge which is easily installed and removed through large access doors in the filter chamber.

Burgess-Manning intake and exhaust silencers are scientifically engineered to prevent — not muffle — noise produced by the exhaust of internal combustion engines, discharge of rotary blowers, vacuum pumps, hogging jets, and steam safety valves, and at the intake of reciprocating compressors and rotary blowers. Silencing of the exhaust stream is obtained by passing the flow through snubbing chambers so that it is discharged to atmosphere smoothly and quietly. Burgess-Manning Snubbers are built like pressure vessels, continuously welded throughout, without excessive weight. A wide range of both standard and special units is available for 1" through 30" and larger pipe sizes.

In our more than 50 years' research and engineering for all types of industries, we have never failed to solve a noise problem. If noise is a problem in your plant, or if you are designing a plant where turbochargers are to be installed, talk to "The Sound Engineering People." There's no obligation, and you'll find us anxious to help you in any way we can. Burgess-Manning Company, 9246 Sovereign Row, Dallas 7.

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SILENT TWINS

MATCHED UNITS for AIR FILTER / INTAKE / EXHAUST

Made by "The Sound Engineering People"

LITERATURE . . .

Process Equipment

Cyclones.....have the unique design feature . . . the "Shave-Off", which stops fine dust from escaping. Literature is available on these Norblo Cyclones.
69 *Buell Engineering Co., Inc.

Dust Collectors.....Bulletin describes line, outlines advantages of large tubes for high efficiencies and resistance to plugging; discusses design and construction.
148A American Standard

Evaporator Stripper.....for recovering chlorinated hydrocarbons from relatively non-volatile contaminants with a high rate of solvent recovery on a continuous basis. Details.
146 *Artisan Metal Products, Inc.

Exhaust purifiers.....Pamphlet describes purifiers for oxidizing carbon monoxide, fumes and odors from gasoline, LP-gas and diesel-powered equipment.
148B Oxy-Catalyst, Inc.

Extractors....8-page bulletin No. 2567 describes complete line of countercurrent liquid-liquid extractors especially suitable for complex extraction operations.
148C Centrico, Inc.

Filter.....Illustrated descriptive bulletin on the Bird-Prayon filter offered. Features a performance record of long sustained operating cycles, constant high output, etc.
2 *Bird Machine Co.

Filter.....The Eimcobelt continuous belt drum filter can handle even the most difficult slurries. The filter medium is always clean. Bulletin F-2053.
Cover *The EIMCO Corp.

Filtration, Engineered.....A complete line to answer the specific requirements of any process application: positive self-cleaning edge-type, porous metal type, etc.
59 *The Cuno Engineering Corp.

Flash Drying Systems.....Send for bulletin with further details on equipment that handles the material automatically in a clean, dust-free operation.
84 *Combustion Engineering, Inc.

Gas Generator.....Bulletin describes new line of packaged nitrogen atmosphere generators; shows typical installations, applications, includes comprehensive flowchart.
148D Gas Atmospheres, Inc.

Lectrodryers.....to dehumidify storage and work areas, thereby safeguarding products during warehousing, processing or packaging. Complete information on request.
136 *Pittsburgh Lectrodryer Div.

Magnetic Stirrer.....capable of mixing & stirring solutions in as many as 6 vessels at one time. Solves problem of stirring several vessels simultaneously, at same speed.
75-761 *U. S. Industrial Chemicals Co.

Micronizers.....grind & classify in one operation in a single chamber & provide fines in range from ½ to 44 microns. Eight models are available. Description in Bul. 091.
144 *Sturtevant Mill Co.

* From Advertisement, this issue

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Circle KEY NUMBERS for more information about . . .

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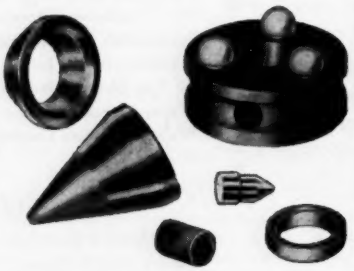

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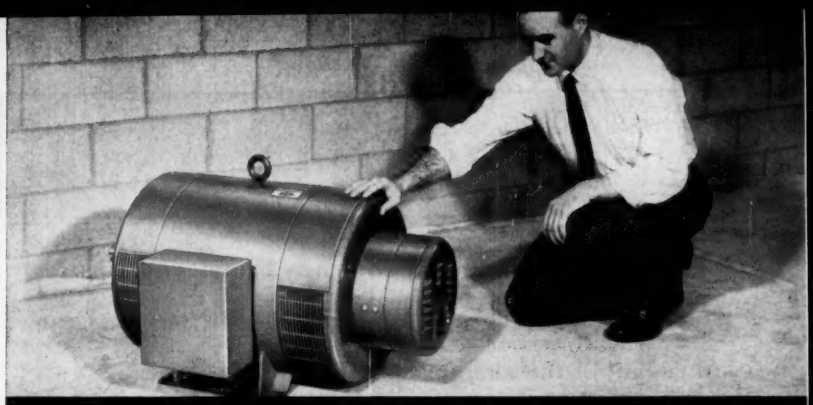

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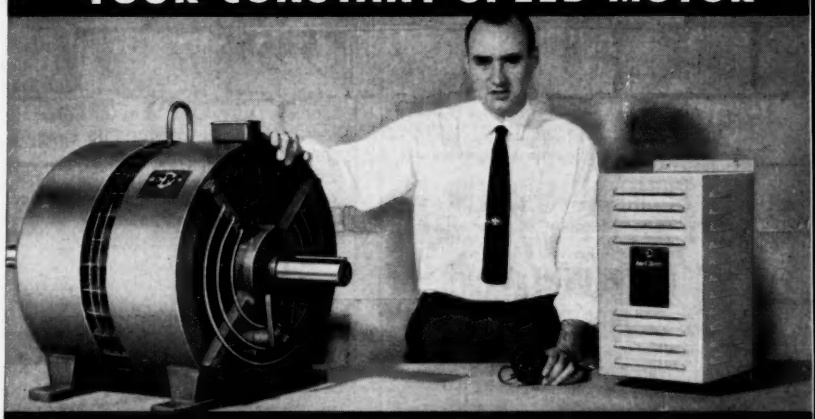

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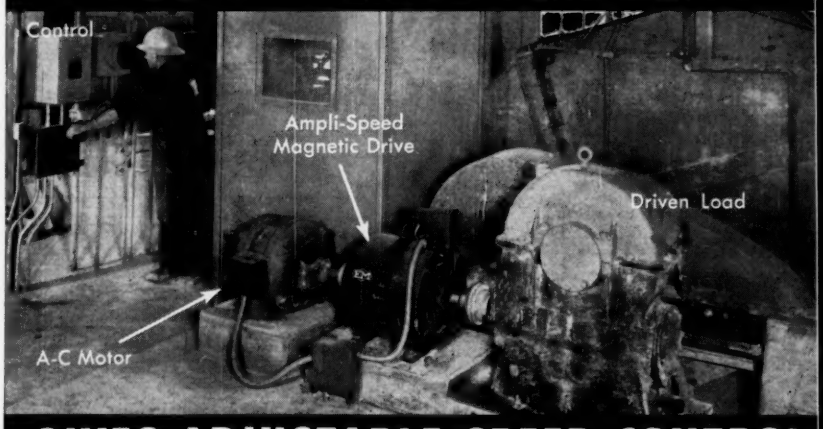

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Mixers: Dbl. and sgl. arms sigma blade. Dry Powder, various sizes. W. & P. size 14, 50 gal. jktd.
Mix-Muller: Simpson Porto 39" st. steel.
Pumps: Rotary, gear, centrif. vacuum.
Screen: Rotex model 41 st. steel.
Still: Double effect st. st. 11.83 gal.
Tablet Press: Stokes DD2, 23 station.
Truck Tanks: Stain. steel 1200, 1600 gal.
Vacuum Pans: 42" and 72" stain. steel.

LOEB EQUIPMENT SUPPLY CO. TELEPHONE SEeley 8-5431 820 WEST SUPERIOR ST. CHICAGO 22, ILLINOIS

CIRCLE H ON READER SERVICE CARD

DIESEL LOCOMOTIVES & CRANES

3—New 25 Ton, 2 GE I Whitcomb.
3—23 Ton, 2-45 Ton Used Gen. Elec.
1—44 Ton, 1-80 Ton Used Gen. Elec.
3—100 & 115 Ton, Gen. Motors, Used.
1—25 Ton, Industrial 60' Boom Loco. Crane.

PLANT EQUIPMENT

2—Wemco 2M-HMS-Plants.
36 x 42 Jeffrey Hammermill, Type B-2.
No. 5060 Dixie Mogul Hammermill 500 H. P.
2—6' x 36" Hardinge Ball Mills.
2—5' x 8' Kennedy Van-Saun air swept Ball Tube Mills with Motors & Elec. Eye.
7' x 24' Allis-Chalmers Tube Mill.
5' x 10' x 7' x 15' Rod Mills.
14 x 28 New England Jaw Crusher.
30" x 36" Traylor Type H Jaw Crusher.
48" x 72" Buchanan Type "C" Jaw Crusher.
56" x 72" Traylor Style G Jaw Crusher.
No. 1 Sturtevant Rotary Fine Reduction.
2' Symons Standard Cone Crusher.
207-10 Type 316 SS LB Roto Louver Dryer.
36" x 20' Ruggles Coles Class XF-1 Rotary Dryer.
#207-10 & #705—24 Link Belt Roto Louver Dryers.
Link-Belt Mono-Tube 24-10 Dryers.
54" x 35' Louisville Monel Steam Tube Dryer.
72" x 28' Madison Rotary Dryer.
5' x 30' Ruggles Coles Class XA-8 Rotary Dryer.
8' x 60' Rotary Dryer, ½" Welded Shell in Calif.
9' x 160' Vulcan Rotary Kiln.
42" x 18" Traylor Type AA Crushing Rolls.
5'-6" x 60' Rotary Dryer or Cooler.
F55 Syntron Grizley Feeder.
24" x 95' NEW Hewitt Robins Truss Belt Conveyor.

R. C. STANHOPE, INC.
60 E. 42nd St. N. Y. 17, N. Y.
Tel. MU 2-3075

CIRCLE J ON READER SERVICE CARD

FOR "IMPOSSIBLE" BUDGETS

1—Allis Chalmers 6' x 50' Stainless Lined Rot. Dryer. W/Mtr. Fan
2—6' x 35' Rotary Flame Dryers. ½" Shell. Comp/equipped
1—66" x 36' Rot. Monel Lined Flame Dryer. With Firebox
1—6" x 12" Lab. 2 Roll Rubber Mill. 5 HP Mtr & Drive
2—French type S-2 Expellors. 30 HP. w/tempering Bins
1—Day Cincinnatus 100 gal work. Cap Sigma Blade Mixer. Size 6
3—Eimco 8' x 12' Rot. Cont. Vacuum Filter. Closed steel drums
1—Falk 50 HP Vert. Agit. Drive. 125 RPM. Louis Allis Mtr

For immediate quote, wire or phone collect—GA 1-1380

ME MACHINERY AND EQUIPMENT COMPANY
123 Townsend St. - San Francisco 7, California

CIRCLE A ON READER SERVICE CARD

OUTSTANDING VALUES!

Mikros 4-TH, 3-TH, 2-TH, 1-SI.
Devine #11 vacuum shelf dryer, 17 shelves.
Ross 60 gallon pony mixer, SS.
10 cu ft double cone blender, SS.

CHEMICAL & PROCESS MACHINERY CORP.
50-52 9th St., Brooklyn 15, N.Y. HY-9-7200

CIRCLE D ON READER SERVICE CARD

BALL MILLS—3' x 12' Abbe/40 HP—4' x 6' Allis Chalmers 60 HP Slip Ring/screwfeeder—Kennedy Van Saun 5' x 6' Enclosed gears/50 HP/scales/feeders/exhausters—Hardinge 6' x 12' w/200 HP Slip Ring/drum feeder.

HAMMERMILLS — 20 HP Gruendler X — 30 HP Mikro 3W—40 HP Jeffrey 24 x 20—50 HP Wms. AKBX—100 HP Jeffrey 36 x 42—450 HP Penna SXT 14.

ROTARY DRYERS—24" x 22'—36" x 24'—44" x 25'—5' x 50' (2) all w/motor drives—burners/blowers avail.

VACUUM PUMPS—115 CFM Beach Russ 100 RP w/5 HP motor/Vee belt drive.

SCALES—12500# capacity dial—Fairbanks Printomatic—8' x 6' Platform.

FEEDERS—Syntron FM1,—FM3—w/hoppers/vibrators/controls.

YOUR BEST REBUILT MACHINERY SOURCE

LAWLER COMPANY
Durham Ave. Liberty 9-0245 Metuchen, N. J.

CIRCLE B ON READER SERVICE CARD

STORAGE TANKS

5—Pressure Vessels, 6' dia. 30' long, Code API-ASME, form 1. Built of ¾" steel. Pressure 200#. Acid resistant brick lined. Outlets are monel metal lined. Mfg: Gen. American Transpn. Corp. Can be converted to Propane Storage by removing the brick.

Further info. on request.

DALTON SUPPLY CO.
2829 Cedar St. Phila. 34, Pa.

CIRCLE E ON READER SERVICE CARD

PIPE

2,000.000 ft. 2" .....3.50# to the foot
1,000.000 ft. 3" .....7.70#
1,000.000 ft. 4" .....10.98#
500.000 ft. 6" .....19.80#
200.000 ft. 8⅝" .....28#
400.000 ft. 10¾" .....35#
75,000 ft. 12¾" .....40#
10,000 ft. 16" .....42#

All No. 1 Grade Plain End and Cleaned
INDIANA-OHIO PIPE CO.
P.O. Box 5412 Shepard Sta. Phone CL 3-5527
COLUMBUS 19, OHIO

CIRCLE F ON READER SERVICE CARD

IMMEDIATE DELIVERY

Disintegrator: Rietz Model RD 18 P w/ 75 HP motor.
Case Sealer: Fully auto. ABC, Elliot, Ferguson.
Mixers: J. H. Day 75 gal. dbl. sigma blade; Baker Perkins 17 dbl sigma blade.
Heat Exchangers: 10 units mfg. Foster Wheeler, 79 to 520 sq. ft. heating surface, type 316 S/S tube and crown sheets.
Blenders: Sprout Waldron 185 cu. ft.; P.K. 20 cu. ft.; Areco 8/8 36 cu. ft.
Pumps: Viking 4" w 7½ HP GH motor.
Pelleter: Sprout Waldron w/ 75 HP motor and cooler.

Send us your lists of idle equipment

AARON EQUIPMENT CO.
9370 Byron Street
Schiller Park, Illinois
Gladstone 1-1500

CIRCLE C ON READER SERVICE CARD

BUY BRILL

SPECIALS

1—Williams 5 Roll High Side Mill, 8' dia. Separator, fan, piping, etc.
1—4000 gal. 316 S.S. clad agitated Reactor with coils.
2—Pfaudler 1000 gal. glass lined, jacketed, agitated Reactors.
1—Louisville 6' x 45', 316 S.S. Rotary Steam Tube Dryer.
2—Buflovak 42" x 120", atmospheric double drum Dryers, complete.
1—Patterson 40 cu. ft. Conical blender, 10 HP.

CENTRIFUGES

2—Baker Perkins 36 HS TerMeer, continuous.
1—Sharples C-27 Super-D-Hydrator, 316 S.S.
1—Bird 18" x 28", 316 S.S. Solid Bowl, Continuous.
1—Bird 36" x 50", 347 S.S. Solid Bowl, Continuous.
2—Sharples PY14, PN14, Super-D-Canters, 316 S.S.
1—Tolhurst 32" Suspended, 316 S.S., imperforate basket.
2—AT&M 48" Suspended, 316 S.S. basket.
2—Sharples #16, 304 S.S., 3 HP motor.

REACTORS—EVAPS—CONDS—TANKS

1—Condenser Service 650 gal. 304 S.S. closed Kettle, 5' x 4', with 100 sq. ft. bayonet heater.
1—1400 gal. Blaw-Knox, steel, jacketed, agitated Reactor.
1—2000 gal. Struthers Wells 316 S.S., jacketed, agtd. Reactor.
2—3200 gal. 316 & 347 S.S., jacketed, agitated Kettles.
1—550 sq. ft. Buflovak monel single effect Evaporator.
1—7500 gal. 316 S.S. Vert. Storage Tank, 7' x 25', 50 psi.
1—750 gal. nickel clad Mixing Tank, 125# nickel coils.
1—4000 gal. Haveg Vert. Tank 8' x 12'.
1—1500 gal. Stainless Pressure Tank, 5' x 10', 90#.
1—12,000 gal. horiz. steel Pressure Tank, 7'6" x 36', 200 psi.
6—Stainless Heat Exchangers: 1220, 786, 536, 370, 315, 250 sq. ft.
1—24" dia. x 35', 304 S.S. Bubble Cap Column.

FILTERS

1—Oliver 6' dia. Horizontal Filter, 216 S.S.
1—Oliver 3' x 6' Steel Rotary Vacuum Precoat Filter.
1—Oliver 5'3" x 6' Rotary Vacuum Precoat Filter, 316 S.S.
1—Niagara #370-38 Filter, 370 sq. ft., 304 S.S.
2—#49 Valles Rotating Pressure Filters, 738 sq. ft.
1—Oliver 5'3" x 8' Steel Rotary Vacuum, vaportite housing.
1—Feinc 5' x 6' Stainless Steel Rotary Vacuum Filter.
2—#10 Sweetland Filters, 27 leaves, 4" centers, 250 sq. ft

DRYERS

1—Buflovak Vacuum Shelf with 20—60" x 80" shelves.
1—Devine Vacuum Shelf with 19—59" x 78" shelves.
1—Devine Vacuum Shelf with 10—40" x 43" shelves.
2—Devine 4' x 9', single drum, atmospheric.
1—Buflovak 3' x 10' Rotary Vacuum Dryer.
1—Baker Perkins 5'6" x 6' Rotary Vacuum Dryer.
2—Louisville Rotary Steam Tube 6' x 25', 6' x 50'.
9—Rotary Dryers, 34" x 30', 4' x 40', 6' x 50', 6' x 60', 7' x 80', 8' x 87'.
2—Louisville 8' x 50' Stainless steel lined Rotary Dryers.
1—Traylor 30" x 18' Stainless steel Rotary Dryer.
2—Link Belt, 7'5" x 25', 6'4" x 24', S.S. Louvre Dryers.

MIXERS

1—Baker Perkins 100 gal., jacketed, double arm, 30 HP.
1—Baker Perkins #16TRM, 150 gal. jktd., Vac. 60 HP.
1—Baker Perkins 50 gal. jacketed, double arm.
5—Day "Cincinnatus" double arm, 250 and 100 gal.
2—Steel jacketed Powder Mixers, 225 and 350 cu. ft.
1—3' dia. Ximpson Intensive Mixer.

MISCELLANEOUS

1—#3TH Mikro Pulverizer, 15 HP.
1—Raymond 10' dia. Single Whizzer Separator.
1—#5 Mikro Atomizer with motor and cyclone.
2—Bantam Mikro Pulverizers, S.S.
1—Ross 6" x 14" Three Roll Mill.
3—Swenson Walker Continuous Crystallizers, 24" x 30' sections.
2—Robinson Sifters, 40" x 84", Stainless.
1—#24 Rotex Sifter, 20" x 64", Quadruple deck.
8—Stokes; DD2, DDS-2, T, "R", and "F" Tablet Presses.
4—Nash Vacuum Pumps; H6, TS7, #2.
25—Chlorimet, Durimet and Duriron Centrifugal Pumps, 1½" to 6".

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35-65 JABEZ STREET NEWARK 5, N. J.
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TEXAS OFFICE—4101 San Jacinto St., Houston 4, Texas—Tel.: Jackson 6-1351

CIRCLE K ON READER SERVICE CARD

LIQUIDATION

TITANIUM DIOXIDE PLANT
BALTIMORE, MD.

CENT.—FILTERS—EVAPS.—CRYSTAL

1—Bird 32" x 50" Cont. Cent. 316 S.S.
4—Sharples C20 Super D-Hydrators, 316 S.S.
1—AT&M 26" sus. Cent., perf. bskt., 316 S.S.
1—Oliver 8' x 8' Precoat rubber covered Rotory Vacuum Filter.
4—Sperry 36" plate & frame Filters, rubber covered, cast iron, and wood.
5—8' dia. x 24' rubber lined Crystallizers.

PULVERIZERS AND MILLS

2—Abbe 5' x 16' brick lined Mills.
2—30" dia. Stainless Steel Micronizers complete with Hoppers, Conveyors, etc.

ROTARY KILNS

1—Traylor 11' x 155' Rotary Kiln, 7/8" shell.
1—Renn. 6' x 60' Rotary Kiln, 5/8" shell.

RUBBER LINED TANKS

5—8500 gal Vertical Storage 8'6" x 16' x 8' cone.
1—13,000 gal. Horizontal Storage 8' x 35'.

STEEL TANKS

6—2000 to 5200 gal. with Turbo Agitators.
14—Storage Tanks: 3800; 6000; 9000; 10,000; 15,000; 47,000 gals.

MISCELLANEOUS

7—Dorr Thickeners: 16' dia. with Tanks.
1—Bemis 50# Bag Packer with Sewing Machine, Conveyor and Flattener.
50—LaBour, Durco, Worthite, Duriron and Stainless Steel Centrifugal Pumps 2" to 6" with motors.

Representatives on premises,
2701 Broening Highway, Baltimore, Md.
Telephone: Medford 3-2911

BRILL EQUIPMENT CO.
35-65 Jabez Street,
Newark 5, N. J.
Tel: Market 3-7420

CIRCLE L ON READER SERVICE CARD

S.S. Blender 150 cubic ft.
Colloid Mills
50 gal S.S. Autoclave 2000 lbs. pressure
3½ gal S.S. Autoclave 2000 lbs. pressure
Vulcanizer 60" x 9' 125 lbs.
Sweetland #2 all stainless
Stainless steel Ball Mill
Proctor & Schwartz finned drum driers

MACHINECRAFT CORPORATION
800 Wilson Ave. (East of Doremus)
Newark 5, N. J. **Mi 2-7634**

CIRCLE M ON READER SERVICE CARD

BEST BUY

STAINLESS DUST COLLECTOR

Rotoclone type N arrangement C size 16. Stainless contact with 40 HP Fan. Excellent condition.

Priced to Sell

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ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. - San Francisco 7, Calif.

CIRCLE N ON READER SERVICE CARD

LIQUIDATING

T316 SS CHEMICAL EQUIPMENT
ORANGE, TEXAS

1—Struthers-Wells 3500 gal. T316 SS reactor, jkt. & 40/20 HP Agit.
1—Alco 110 sq. ft. T316 SS vert. pressure leaf filter.
2—Vulcan 96" dia. T316 SS bubble cap columns, 37' high
1—Vulcan 72" dia. Copper column 4' high, VACUUM.
1—17,650 gal. T316 SS horiz. tank, dished heads, coil
3—Worthington 160 ton steam-jet Vac. refrigeration units.
2—Sharples #C-20 Super-D-Hydrators, T316 SS
2—Buffalo type #R, T316 SS blowers, 2330 cfm, 60 HP
2—American type #R T316 SS blowers, 5600 cfm, 50 HP
2—Read 1800 cu. ft. T304 SS weigh hoppers, with T304 SS elevators, shaker conveyors, etc.
1—Struthers Wells 630 sq. ft. T316 SS evaporator.

MANY, MANY OTHER ITEMS
SEND FOR ILLUSTRATED CIRCULAR #1259A

TANK–VESSELS

3—18,000 gal., vert., alum., 12' x 31', cone bottom
1—17,650 gal., horiz., T316 SS, 9' x 36', ¼" shell, ⅜" dished heads, 40# WP.
1—5800 gal., vert., alum., 10' x 10', agit.
10—4500 gal., vert., Nickel-clad, 8' x 11', 125# WP.
1—3700 gal., vert., T304 SS, 6' x 17' VACUUM, int. coils.
1—3300 gal., vert., T304 SS, 6' x 14'6", ⅜" shell, ⅜" heads, 70# WP.
1—2830 gal., horiz., T316 SS, 6' x 12', 5/16" shell & dished heads, VACUUM.
3—2750 gal., vert., T316 SS, 7' x 8', dished heads, 50# WP, 75 sq. ft. coil.
4—2600 gal., vert., T316 SS, 7' x 8', flat bottom, 19# WP, 5 HP agit.
1—2500 gal., vert., T316 SS, 7' x 7', ¼" shell, 5/16" dished heads, 70# WP.
5—2250 gal., vert., T316 SS, 7' x 6'3", dished heads, 70# WP, 5 HP agit.
1—2100 gal., vert., T316 SS, 6' x 9'10" open top, cone bottom.
1—2100 gal., vert., alum., 6' x 10', dished heads.
1—1900 gal., vert., T316 SS, 6' x 8', ⅜" shell & dished heads, VAC. or 100#.
12—1750 gal., vert., hoppers, T304 SS, double cone bottom.
2—1200 gal., vert., T316 SS, 5' x 7', cone bottom, VACUUM.
100—Tanks & vessels, 100 to 1000 gal., all types, etc.

JUST PURCHASED

1—Baker-Perkins #15-UUMM 100 gal. Dispersion mixer, 100 HP, jacket, compression cover, screw tilt.
2—Buflovak VACUUM Shelf Dryers; 110, 98 sq. ft.
3—National Iron 10' dia. x 78' long rotary dryers, ¾" shell, 4' dia. center tubes.

FILTERS—CENTRIFUGALS

1—Niagara #510-28, 510 sq. ft. vert. leaf, T316 SS, ASME.
1—Alco 110 sq. ft., T316 vert. filter.
1—Eimco 18" dia. x 24" face T304 SS rotary vacuum.
2—Oliver 5'3" dia. x 3' face rot. vac., pressure precoat, T316 SS, ASME 30# pressure housing.
1—Oliver 5'3" dia. x 8' face, rot. vac., precoat, steel; UNUSED.
8—Sharples #AS-16V super cent. Inconel. Vapor-tite, 3 HP sludge disch.
2—Sharples #16P, T304 SS pressure-tite
3—Sharples #C-20 Super-D-Hydrators, T316 SS.
1—Bird 32" x 50" horiz. cent., T316 SS.
2—Sperry 30" P. & F. filter presses, 19-9 st. st. (NI-RESIST).

HEAT EXCHANGERS—CONDENSERS

1—1960 sq. ft. T316 SS exchanger, ASME
1—1450 sq. ft. T316 SS vert. condenser.
1—1070 sq. ft. cupro-nickel condenser.
7—800 sq. ft. T316 SS vert. condensers.
5—400 sq. ft. T316 SS vert. condensers.
50—T316 SS condensers & exchangers: 735, 427, 300, 264, 250, 235, 200, 165, 150, 125, 110, 47, 30 sq. ft.
25—Copper & cupro-nickel exch. & cond.

LIQUIDATING

CRUSHING-GRINDING PLANT

MANCHESTER, CONN.

17—Abbe Eng. #1B pebble mills, 6' dia. x 8' long, buhrstone lined, 30 HP motors & drives.
2—Hardinge 7' x 36" conical mills.
1—Allis Chalmers 6' x 18' pebble mills.
1—Christie 4'6" x 45' rotary dryer.
1—Symons 3' short head cone crusher.
1—Buchanan 13" x 24" JAW CRUSHER.
3—Bucket elevators, up to 50' high.
3—16" trough belt conveyors, to 182' long.

SEND FOR CIRCULAR #360A

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Phone POplar 3-3505

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UNUSUAL EQUIPMENT
rarely offered for RESALE

Struthers Wells Stainless Drum Dryers; 5' x 10'; 5' x 4'.

Buflovak Double Drum Dryer; 40" x 120".

2 Monel Reactors 2800 Gal with Turbine Agts.; Jktd. 175 #ASME.

14 S/S Pressure Tanks; 700 Gal.

Nickel Clad Reactor 7' x 11'6"...

Struthers Wells Type 316 S/S Jacketed & Agitated Reactors, 1000-2000 Gal.

9 Devine Vacuum Chamber Shelf Dryers from Lab. Size to No 36.

Sweetland Filters No 2 to No. 12.

Oliver Continuous Rotary Filters, & Feinc Rotary Vac Filters, Sizes up to 8' x 10'.

Sparkler Stainless Filter; 560 sq. ft.

Shriver, Sperry etc. Filter Presses, Cast Iron, Ni Resist, Stainless etc. From 7" to 54"

Stainless Nutsche Filter 6' x 2'.

Fitzpatrick S/S Comminutators

Mikro Pulverizers; Bantam to No. 4's.

Williams Hammer Mills; up to 200 HP.

Raymond Imp Mills; All Models Now in Stock.

American Ring Roll Crusher; 50 HP.

Abbe Ball & Pebble Mills; all sizes.

Fletcher and Tolhurst Centrifugals, S/S Rubber Cov.; Monel to 60".

Bird Continuous Hor. Conical Centrifuges 18" x 28"; and 24" x 38".

Farrel-Birmingham Rubber & Plastic Mills, 14" x 30", 16" x 42", 18" x 42", 22" x 60".

2 Adamson Vulcanizers; 16' long. Extruders NRM, Royle, Allen; many sizes.

Brand NEW Falcon Double Ribbon Blenders in Stainless or Mild Steel; All Sizes.

Heat Exchangers and Condensers in Stainless, Monel, Nickel, Karbate.

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239 TENTH
BROOKLYN 15, N. Y.
Sterling 8-4672

CIRCLE P ON READER SERVICE CARD

CHEMICAL EQUIPMENT DIVISION

Raymond 3 Roll #3036 Hi-Side Mill
Buflovak 19 Shelf Vacuum Shelf Dryers
1000 sq. ft. Stainless Heat Exchangers (2)
Tolhurst 40" S.S. Center Slung Centrif.
Fletcher 40" Susp. Steel Centrifugal
Sweetland #12, #10, #7 Filter Presses
30 Gal. S.S. Jktd. Autoclave 1000 PSI Int.
Shriver 30"x30" P&F 36 C.I. Chambers
Nooter 750 gal. Steel Reactor 300 PSI
Traylor 8' x 11' Ball Mill
Beth. Fdry. 7' x 24' Compeb Mills
Link Belt 302-16 Roto-Louvre Dryer
8' x 80' Rotary Dryer 316 S.S.
Mosser 4' x 47' Rotary Dryers
Louisville 6'x50'; 6'x25' Steam Tube Dryer
F. J. Stokes 38A & 382A Tray Dryers
Stainless Tanks 100, 200, 350 gal.
Condensers 100 to 5000 sq. ft. Steel; Admir.
Pressure Vessels 300 to 4500 gal.
Dixie #5060 Mogul Hammermill
Jeffrey Hammermills 36" x 36"; 15" x 8"

HEAT & POWER CO. INC.
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CIRCLE Q ON READER SERVICE CARD

COMPRESSORS
World's Best Rebuilts

74 CFM 1500 PSI 6½-3⅝-1⅝x7 CP. TCB3
100 CFM 150 PSI 6x7 Ing. ES-1
104 CFM 2500 PSI 6⅝-4¼-1 11/16x9 IR-ES3
110 CFM 3000 PSI Ing. GC 508W
138 CFM 100 PSI 7x7, Ing. ES, CP & Joy
151 CFM 3000 PSI 13¾x12 Norwalk TRS-4T
167 CFM Vac. 10x5 Ing. Type 15
288 CFM 100 PSI 9x9 Ing. Worth. CP & Penn
311 CFM 1500 PSI 10½-7⅛-3½x13 IR-ES3
351 CFM 350 PSI 11-5x11 CP TCB-2
465 CFM 100 PSI 12x11-IR-ES-1-Chic. P.T.
686 CFM 100 PSI 14x13 Ing. ES-Chic. P.T.
823 CFM Vac. 18x7 Ing. ES-1
877 CFM 125 PSI 17-10½x14 IR, XRB
1545 CFM 110 PSI 21-13x14 Ing. XRE
2506 CFM 50 PSI 19-19x14 Pennsylvania DE-1
3078 CFM 110 PSI 30-18x21 Ing. PRE 2
3135 CFM Vac 31x13 Ing. ES Worth HB

AMERICAN AIR COMPRESSOR CORP.
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CIRCLE R ON READER SERVICE CARD

WIRE US COLLECT!

MONEL DRYER

Louisville 54" x 35' long Rotary Monel Steam Tube Dryer. 1120 sq ft heating surface. 150# pressure. Code construction. New 1954

Used only 1 year

ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. - San Francisco 7, Calif.

CIRCLE S ON READER SERVICE CARD

ECH SPECIAL

Abbe Eng. Jacketed 5' x 6' Ball Mill, chrome manganese steel. Price $2750.00.

EQUIPMENT CLEARING HOUSE, INC.
111 33 Street Brooklyn 32, N. Y.
SOuth 8-4451—4452—8782

CIRCLE T ON READER SERVICE CARD

Dryers, Kilns, Centrifugals, Filters, Kettles, Tanks, Grinders, Crushers, Mixers, Screens, Tablet Machines, etc. Hydraulic, Plastic and Rubber Machinery. Send for bulletins.

STEIN EQUIPMENT CO.
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Sterling 8-1944

CIRCLE U ON READER SERVICE CARD

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This service is aimed at helping you the reader of "SEARCHLIGHT", to locate Surplus new and used equipment not currently advertised. (This service is for USER-BUYERS only.)

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PROCESSING EQUIPMENT

1—Struthers Wells type 347 SS 400 gal. reactor with coils and turbine type agitator
1—Oliver type 316 SS rotary vacuum filter, 4' x 5'
3—Struthers Wells type 316 SS jacketed reactors, 2000 gal. complete with agitators and drives
1—Buflovak SS 2' x 4' jacketed rotary vacuum dryer

AUTOCLAVES, KETTLES AND REACTORS

1—Van Alst 250 gal. S.S. jacketed kettle complete with SS column and condenser
2—Pfaudler 200 gal. glass lined jacketed, reactors, complete with anchor type agitators and drives
1—Pfaudler 100 gal. glass lined jacketed reactor, complete with anchor type agitator and drive
1—Steel and Alloy Tank Co. 100 gal. type 347 SS pressure tank, 250 psi jacket
1—Blaw Knox 400 gal. steel jacketed autoclave, 570# internal pressure, 85# jacket
1—18,000 gal. type 316 SS pressure tank, 11' x 24', 60 psi
1—Blaw Knox 45 gal. jacketed autoclave, 1500# pressure
1—Patterson Kelley 6000 gal. steel jacketed kettle
2—Steel jacketed reactors 2500 gal.
1—18,000 gal. aluminum storage tank
5—Aluminum storage tanks, 1300 gal. each

DRYERS

1—Allis Chalmers SS 6' x 50' rotary dryer, complete
10—Allis Chalmers rotary dryers, 4' x 20', 6' x 50' and 7' x 60'
3—Link Belt steel roto louvre dryers, Model 207-10, 310-16, 604-20
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
2—Louisville rotary dryers, 8' x 50', SS
1—Buflovak SS jacketed rotary vacuum dryer, 3' x 15'
3—Buflovak steel jacketed rotary dryers, 3' x 15', 5' x 20' and 5' x 35'
1—Traylor 4' x 40' rotary dryer
1—Rotary dryer 6' x 36'
1—Western Precipitation Corp. SS pilot spray dryer, Type N-2

FILTERS

3—Dorrco rubber covered filters, 6' x 2'
12—Sweetland #12 filters with 72 SS leaves
1—Niagara SS filter, Model 510-28
1—Oliver SS rotary pressure precoat filter, 5'3" x 8'
1—Oliver horizontal filter, 3'
10—Shriver plate and frame filter presses, 12" to 42"
1—Shriver aluminum 30" x 30" P&F filter press, 30 chambers

CENTRIFUGES

1—AT&M 48" SS suspended type centrifuge, complete with plow, motor and imperforate basket
1—Fletcher 48" center slung SS centrifuge complete with perforate basket and motor
4—Tolhurst 40" center slung rubber covered centrifuges with perforate baskets and motors
2—Fletcher 40" center slung rubber covered centrifuges with perforate baskets and motors

THE GELB GIRL—MAY 1960

MIXERS

2—Sturtevant #7 dustite rotary batch blenders, NEW
15—Robinson type 304 SS horizontal blenders, 255 cu. ft.
1—Howes horizontal rubber covered ribbon blender, 40 cu. ft.
1—Baker Perkins Size 16 Type TRM, 150 gal. jacketed double arm sigma blade mixer with vacuum cover
1—Baker Perkins Size 20, 2000 gal. double arm jacketed vacuum mixer with double naben blades
1—Entoleter impact mill type PPM-27
1—Stokes SS granulating mixer, Model 21J
3—Banbury #1 mixers, chrome plated rotors, with 50 HP motors
1—Baker Perkins Size 16, Type UUEM, 150 gal. jacketed double arm dispersion type mixer, complete with compression cover and 100 HP motor

MISCELLANEOUS

1—York Shipley 175 HP package steam generator, 135# psi
1—Vulcan SS bubble cap column, 4' x 25 plates
1—Badger type 316 SS bubble cap column, 42" dia. with 11 trays
1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays
1—Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
1—Condenser Service type 316 SS heat exchanger, 350 sq. ft.
3—Badger type 316 SS heat exchangers, 500 sq. ft. and 600 sq. ft.
10—Davis Engineering SS heat exchangers, 145 sq. ft. (NEW)
1—Downington type 316 SS heat exchanger, 750 sq. ft.
1—Mikro Model 1SH pulverizer
2—Swenson type 316 SS vacuum crystallizers, 3'6" x 12', 2' x 12'
3—Williams type 316 SS hammermills, Model AK
1—Sprout Waldron Model 501-D pelleter
1—Ross 6" x 14", 3 roll paint mill, complete
1—Stokes stainless steel coating pan, 3' dia.
50—Steel heat exchangers, 15 sq. ft. to 100 sq. ft.

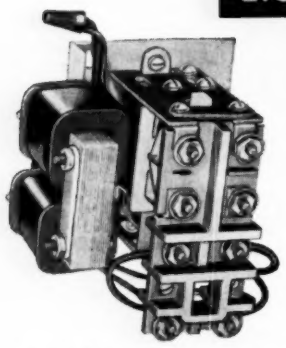
1—Richmond Engineering type 316 SS 40 cu. ft. horizontal double ribbon blender
4—Davis Engineering Carpenter 20, 125 sq. ft. heat exchanger, NEW
2—2500 gal. monel jacketed autoclaves, 175# jacket and 175# internal
1—Pfaudler Model XL 1000 gal. glass lined jacketed reactor complete with anchor type agitator and drive

R. GELB & SONS, INC.
U. S. HIGHWAY 22, UNION, N. J. · MURDOCK 6-4900
75 ANNIVERSARY

CIRCLE V ON READER SERVICE CARD

WARRICK

Floatless, Electrode Type
LIQUID LEVEL CONTROLS



Two pole control shown above

give you all these advantages!

No moving parts in the liquid • Easy to install • No adjustments necessary • Unaffected by acids or caustics • Unaffected by pressure or temperature • Standard 2&3 pole units listed by U/L

Write for 32-page Catalog which gives complete specifications

Special controls to custom requirements

YOU CAN USE OUR CONTROLS FOR:

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CHARLES F. WARRICK COMPANY

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Transfer Many Thermocouples

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Connector Panels T-E has one for your exact needs. These panels provide flexible, centralized control in transferring any number of thermocouples to indicating, multi-point recording and controlling pyrometers. Ideal for patch panel use, they are available in many compact shapes and sizes — with interchangeable plugs and jacks in I-C, C-C, and C-A. A panel for 48 thermocouples and 16 pyrometers measures only 13¼" x 7⅞". Polarity markings and screw-fastened connections make wiring easy.

Quick-Coupling Connectors These connectors permit fast, easy making and breaking of thermocouple circuits. Durable construction guarantees long, dependable usage. Polarized and mechanically interchangeable, all plugs and jacks are of standard matched thermocouple materials. Spring-loaded contacts with long wiping surfaces provide firm but easily broken connections.

Write for Bulletin 23 — 4

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SADDLE BROOK, NEW JERSEY
In Canada — THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

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with superior

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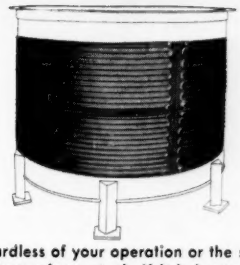

Regardless of your operation or the size or shape of your tank, if it is heated or cooled, Dean Panelcoil can do the job more economically and more efficiently than old-style pipe coil or jacketing.

For complete technical data and pricing, write for Data Sheet 15-60 Series and Price Bulletin 259.

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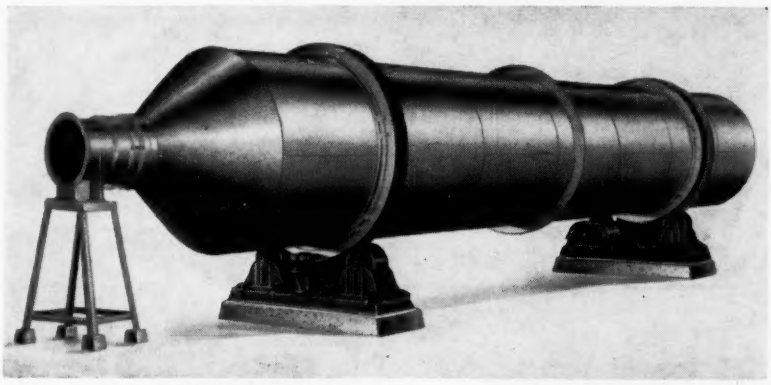
STerling 9-5400

Backed by 25 Years of Panel Coil Manufacturing



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Rotary Flash Type Air Cooler

If you have a cooling problem on a granular product, you should investigate the DAVENPORT Rotary Flash Cooler. The unit shown is a 7'-0" diameter x 45'-0" long and is designed for cooling 800 tons of product per day using ambient air.

Let our engineers consult with you on your Pressing, Drying and Cooling problems or send for our catalog "A" For quick reference consult your Chemical Engineering Catalog.

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ROTARY COOLERS
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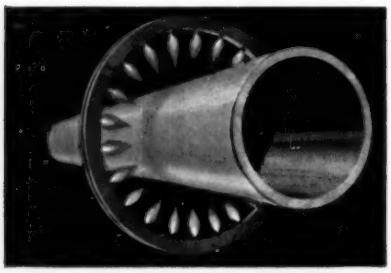
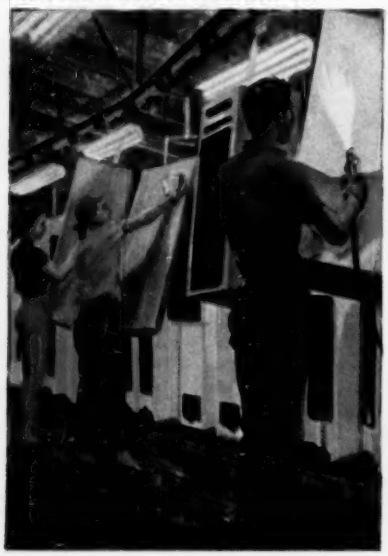


Flame curing produces the tough, chemical-resistant Buton coating 20 to 50 times faster than conventional baking techniques.

Now Enjay presents new high-quality, lower-cost, low-density resins. The Buton Resins – (formerly called C-Oil and Butoxy Resins) – can be blended with ureas, melamines, short and medium oil alkyds, vinyls, phenolics and nitrocellulose to obtain specific properties. They can be cured by air dry – force dry cycles, low-temperature bakes, high-temperature bakes and by a new process called flame curing. Use of this new process is unique in that it enhances the properties of Buton rather than degrades them, as is the case with other resins.

IN APPLIANCE PRIMERS



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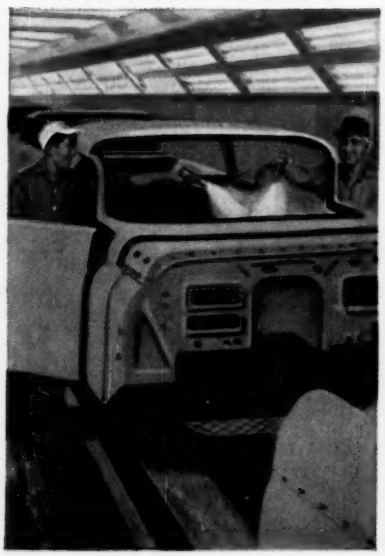
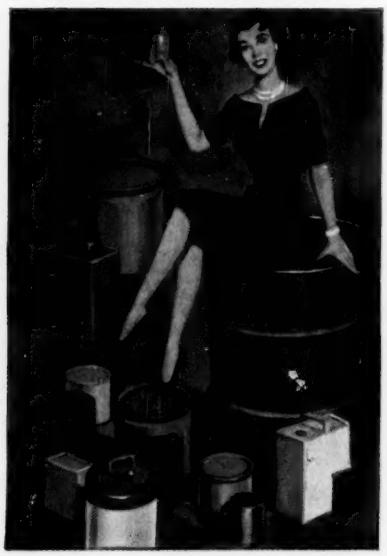


IN CONTAINER COATINGS



...OFFER PROFITABLE NEW OPPORTUNITIES FOR THE SURFACE COATINGS INDUSTRY

Buton Resins are suggested for use in primer formulations for appliances, automobiles and metals of all types. They can also be formulated for use in coating metal containers, cans, drums, etc.

Enjay offers you free technical assistance and guidance from one of the world's best staffed and equipped petrochemical laboratories. Here, Enjay can help your product do a better job through efficient use of Buton Resins.

FOR FURTHER INFORMATION or to order Buton Resins, call or write the Enjay Office nearest you.

BUTON RESINS PROVIDE THESE PROPERTIES

- Good Chemical Resistance
- High Bulk
- High Gloss
- Good Pigment Wetting
- Excellent Adhesion
- High Compatability
- Good Electrical Resistance
- Tolerance for Inexpensive Solvents
- Lower Cost Than Other Quality Resins

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IN WOOD FINISHES

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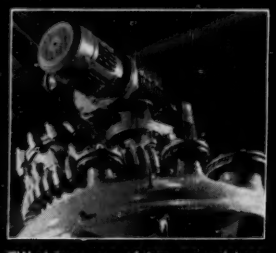
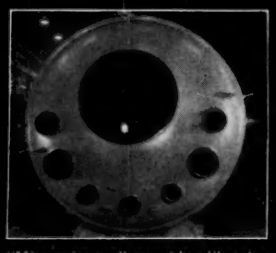
PETROCHEMICALS

FLUIDICS AT WORK

from top to bottom... Pfaudler "RA" Series Reactors

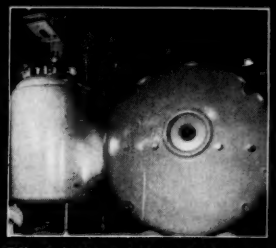


TW drive, one of two new drives, provides increased stability for agitator shaft. Runs very quietly.



"Mirror image" provides like-size nozzles on each half of top head. Facilitates piping.

Different silhouette and light-blue exterior tell you the Pfaudler "RA" Series Glasteel Reactor is new. Unit shown has BH drive.



Offset bottom head outlet is in sweep path of agitator and in line with top head manhole.

The old "Pfaudlers" (R Series) that you're so familiar with are passing from the scene.

In their place, we now offer you the all new "RA" Series Glasteel Reactors with many significant design improvements.

Two New Drives. Starting at the top you'll find the TW drive on the 300 through 1000 gallon reactors for power requirements to 15 H.P. The BH drive takes over on the 1500 gallon and larger sizes for power requirements to 60 H.P.

Both drive designs are compact, easily installed and maintained. Very quiet, too – a difference that's appreciated when operating a full line of reactors.

Mirror Image Top Head. Next, note the equal number of nozzles on each half of the top head, placed symmetrically for ample freedom in piping. For example, you can feed two reactors from a single tee—one to the left, one to the right.

And since there are no cumbersome drive supports, you have convenient access to manhole, observation window, nozzles, drives, baffles, dip pipe and mechanical seal.

Offset Drain. Off the bottom head you get fast drainage, since the outlet has been offset from center to a position in the direct sweep-path of the agitator. Also, the outlet is in line with the top head manhole for convenient inspection.

Corrosion Resistance. Of course, inside there's Glasteel 59. Excellent resistance to all acids (except HF) to 350°F. and on to 450°F., depending on concentration. Mild alkalies at moderate temperatures are also permissible. Thermal shock resistance is up 30% over the "R" series. At a vessel temperature of 250°F. your recommended safe temperature differential is now 260°F. Abrasion resistance has also been increased by 20%. Glasteel 59 is smooth —resists build-up of sticky products. As a result, you have high heat-transfer rates, increased product yield, fewer shutdowns for cleaning, and much longer service life.

Stock Delivery. Standard "RA" Series Reactors range in size from 300 to 4000 gallons. The 500, 750, 1000 and 2000 gallon vessels, fully assembled with standard drives and agitation, are prestocked for *two-week* delivery from receipt of your order.

Write for Specifications. New Bulletin No. 988 is now available. For your copy, write to our Pfaudler Division, Dept. CEB-50, Rochester 3, New York.

FLUIDICS AROUND THE WORLD

Pfaudler Permutit is a world-wide company with manufacturing plants in: Germany, Great Britain, Canada, Mexico and Japan, as well as four plants in the U. S. A.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

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